ENGINEERING NEWS

THE worst accident since the fall of the Bussey bridge, and in its way quite as unnecessary and inexcusable an accident, occurred at 7 A. M. of Friday, July 15, at St. Thomas, Ont., at a nearly right-angled crossing of two straight and level roads, the Michigan Central (Canada Southern Div.) and a North and South branch of the Grand Trunk. A passenger train on the latter ran into an oil train on the former, causing a terrible fire at once, which resulted in killing 12 and burning or otherwise wounding over 100 others, all for lack of safety precautions which have been known and approved for years and have been for years in very wide use. As we shall comment on the accident more fully in our next issue it seems unnecessary to say more here.

BOTH branches of the city government of Providence have passed a resolution adopting the GRAY plan of intercepting sewers, which we suppose means that the works will soon be carried out. The plan contemplates the construction of intercepting sewers on each bank of the Providence River, and the erection of pumping works near Field's Point, some three miles below the city, with precipitating tanks so as to give a clear effluent. The nuisance from the present system, or rather lack of system, has become a great one. Construction will begin at the pumping works and a considerable system of branch sewers is also contemplated. We refrain from further descriptions as we shall illustrate the works at the proper time.

ANOTHER "fire proof" storage ware house was burned up like a tinder-box in New York on the 16th inst. destroying an immense amount of property on which there was little insurance, because the owners had relied on the "fire-proof" allegations. That it is not impossible to build storage warehouses which shall be practically fire-proof, and shall yet be able to afford storage on reasonable terms, is proved by experience with two or three buildings like the Lincoln and Manhattan, which are probably as nearly fire-proof as is reasonably possible and so nearly so that a fire is not likely to get headway in them. But the great public, which is so ready to fall upon railway corporations for failing to properly protect them, cannot or will not protect itself in such matters as these, on which it can act intelligently and which it has completly in its own hands.

A COLLISION which appears to have resulted from an inexcusable violation of established operating practices occurred on the Northern Railroad of New Jersey last Monday. It appears that the Nyack express had two engines up a long hill, the "pusher" being in front. At the top of the grade the "pusher" cut off and ran down the hill ahead of the regular train and ahead of its time. Collision naturally resulted with an unoffending freight train which was relying on the established operating rule that no train shall run ahead of its schedule time. Probably the guilty engineer has been discharged but the underlying cause for most such occurences is a lack of salutary discipline which shall make employés instinctively avoid such recklessness.

THE difference between killing a dozen or twenty and almost killing 1,500 or 2,000 was never better illustrated than by the small notice taken of a threatened disaster to a heavy excursion train load of 1,500 school children on the Indianapolis & Vincennes Railroad on June 30 last. At the bridge over White river some rotten old sills gave way and dropped the track two feet, causing a tremendous jolt to the train in passing over it, but it did pass over it, and no one was seriously hurt. This was because there happened to be some remnants of old timbers below to hold the track up, for the moment at least. Had this not been the case there might well have been a frightful disaster which would have stirred up the whole country, and brought the management of the road under as severe condemnation as did the Bussey bridge; but the probabilities are that most of our readers will now hear of this event for the first time, although it belongs to a class of events which are the least excusable among engineering disasters, because the causes for them can always be detected in advance by moderate care alone.

THE Institution of Civil Engineers has just been defeated in a suit claiming exemption from taxation on its estate on the ground that it was "legally appropriated and applied for the promotion of education." The Court held that instruction in a specific art or science did not constitute "education" within the meaning of the act, and the Institution must pay its taxes, as we believe the American Society has to.

WE must go abroad to hear the news: *Engineering* tells us in its last issue that "at Quincy, Ill. a man with a parachute leaped from a balloon when at a height of 5,000 ft. and reached the ground safely." Perhaps he did, but we never heard of it till yesterday; as the Irishman remarked when he fell upon the Jew, in the story almost everyone has heard.

THE *Iron Trade Review* describes at great length the new Bristol iron mines a few miles north-west of Ottawa, Canada, which appear to be a remarkably fine deposit, having the merest trace of phosphorus but a good deal of sulphur. The ore is to be roasted on the ground at a cost of 55 cts. to get rid of the latter, and it is claimed that it can be laid down in Cleveland O., at $4.25, $2.15 of which is for transportation and 75 cts. for duty, while similar ore is selling in Cleveland at $6 to $6.50. A strong company has been organized to work the mine.

THE Brooklyn locomotive strike completely failed —very fortunately. It is a lesson which both employers and employés need to learn that it does not do to strike first and negotiate afterwards, and both seem to be learning it. The Locomotive Engineers' Brotherhood has been of later years the model labor organization, although it begun its existence ten or twelve years ago with some outrageous performances. And in nothing has its good sense been better shown than in its absolute refusal to back this strike, through the presence of their well named "Grand Chief Engineer" P. M. ARTHUR, who may fairly be said to be the brains and balance-wheel of the organization, if any one man can, and who has in repeated instances shown such good judgment, self-control, and diplomatic skill as to win him the respect of the entire community. But as a stream cannot rise above its source, the entire Brotherhood may justly claim the credit for keeping such a man at the front, and for illustrating by their conduct that trade organizations are not necessarily lawless nor evil.

THE north heading of the Hudson river tunnel is now 1,775 ft. from the shaft, the daily average of completed work since the start being about 2½ ft. The lock at 800 ft. from the shaft has been thrown open, so that the tunnel for a distance of 1,200 ft. from the shaft is only under normal pressure. The pressure in the heading averages about 31 lbs. per sq. in. The difference in the pressure required at high and low tide is about 2 lbs. The material passed through (silt) is compact, tenacious and remarkably free from sand and soft spots. It is not considered necessary to bore the heading, or in any other way endeavor to ascertain the character of the material ahead except by such indications as are afforded by the pilot, which is usually from 10 to 15 ft. in advance of the face of the work. The silt is removed in squares resembling small cakes of ice (in shape only) and such is its tenacity and plasticity that most of these squares reach the surface, retaining their shape with the exception of rounded corners and edges.

We are informed that there is no foundation whatever for the reports which have been more or less widely circulated to the effect that the Pennsylvania Railroad Company had obtained control of the work, and would push it vigorously. As we understand it, and have good reason to believe, the tunnel is now, as it always has been, controlled by a private corporation, independently of any railroad or railroad scheme. Other assertions concerning another attempt to build a tunnel, appear to be without foundation. It seems reasonable to believe that no other tunnel will be commenced until the present undertaking is either completed or abandoned.

THE utility of *Punch's* famous remedy for rail way disasters, to tie a director to each locomotive, may perhaps be illustrated by the accident to President CLEVELAND'S train from a broken connecting-rod, which killed the engineer and might well have wrecked the train. The connecting-rod is a weak spot in every locomotive, and it is a safe surmise that every motive-power man in the country has had his attention directed to it anew by the accident, and, if his practice be bad, will be more disposed than before to reconstruct it. The difficulty in proportioning the part is that it is not possible to gain much greater safety from increase of weight, since it is largely its own weight which destroys it, and the strain on the outermost fibres is thereby not much reduced. No reasonable doubt remains that the I-section is by far the best, as theory indicates, yet there are many roads which do not use it, if not a majority, besides which there is the fact brought out by WÖHLER, of which too many Master mechanics are wholly ignorant, that it is only a question of time when any part subjected to such severe alternating strains will break, so that the connecting-rod may be quite safe for three or four years' service and quite unsafe for eight or ten. Yet the roads which act accordingly by fixing a specified mileage for connecting-rods, are the rare exception.

THE Inter-State Commerce Commission has added greatly to the useful work which it has heretofore done by sitting down in what will probably prove a very effectual way on the practice of paying commissions to ticket agents of connecting roads for sales of through tickets; in other words, for inducing passengers who confidingly apply to them for unbiased information to take a route which they otherwise would not. The commission often rises to 20 or 25 per cent., and its demoralizing and corrupting tendency is evident enough to all disinterested persons, but the absence of all effectual control over inter-state roads has heretofore made it impossible to check the practice, although no private firm would tolerate a similar compensation to its salesmen for a moment.

THE Panama Canal lottery bonds are to be offered simultaneously in Paris and New York on July 26. As only a limited amount is allotted to this country early application will make it surer that applicants can secure all the bonds which they desire.

Mr. FRED. LAW OLMSTED has felt obliged to come out with a letter denying that he has been re-engaged as landscape architect of the park, and stating that he could not consent to be so except in conjunction with his former coadjutor, CALVERT VAUX. The way in which these benefactors of the city, who may fairly be said to be the creators of Central Park as it is to day, have been quietly dropped out of its artistic management is one of the most discreditable incidents in the history of the Park Commission.

THE worst storm known at Pittsburg since the great Butchers' Run disaster of 13 years ago, when nearly 200 persons were drowned, came to it this week, but did comparatively little damage. The rainfall was enormous, 2½ ins. in two hours. Many houses were washed away and heavy washouts are reported on all the roads entering the city; some of them, we do not doubt, of structures which went through the storm of 13 years ago uninjured.

THE Canadian government has backed to the full extent the Canadian Pacific objections to rail connections of Manitoba and the United States, as was inevitable from its agreement with that road. But the absurd obstacle thus placed on the natural development of that promising province can hardly fail to cause the deepest discontent which will make trouble hereafter, and that speedily.

THE great B. & O. deal seems to be done for at last, and judging from the inside facts which are now coming out, there have been few instances of so much smoke for so little fire. Should the B. & O. succeed in getting its Staten Island terminal at New York however, which seems almost certain, the policy of its management can hardly help changing considerably, whether the management itself does or not. It will almost be forced into a somewhat expansive policy.

"Dredging Operations and Appliances."*

BY JOHN JAMES WEBSTER, M. INST. C. E.

(*Concluded from page 36*).

BUCKET-LADDER DREDGERS.

The first bucket-ladder dredger appears to have been constructed for cleaning the Old Dock at Hull, now called the Queen's Dock. This dredger commenced to work about five years after the opening of the dock in 1778, and is described by Mr. TIMPERLEY in the Transactions Inst. C. E.[1]

The first bucket-ladder dredger driven by steam was designed for cleaning Sunderland Harbor.[2] Almost contemporaneous with this machine was one constructed for cleaning the Humber Dock at Hull, and designated a "mud machine" in the records of the Hull Dock Co. It consisted of a square flat-bottomed boat, 80 ft. long, 20 ft. broad, and 5 ft. draught. It had a single ladder with twenty-nine buckets, and was worked by an engine, with a cylinder 15 in. in diameter, 24 in. stroke, and making 40 strokes per minute. Under favorable conditions, it was capable of dredging 120 tons per hour; but the average work was 45 tons per hour.

To obtain the most favorable results with a bucket-ladder dredger, it should be designed for the work it has actually to perform; and the circumstances and conditions of each particular case should be taken into consideration.

Single and Double Ladders.—One of the first points to settle is whether a dredger should have a single, or a double ladder, each type having its own special advantages.

As a rule, the single-ladder dredgers are smaller machines than the double ones; though many of the powerful dredgers now working in British and foreign ports have single ladders. The single ladder has the advantage of being able to discharge into a barge, on either side of the vessel, by regulating the shoots; whereas, with a double ladder, each one can only discharge on its own side. The single ladder has thus an advantage in working near a dock-wall, or when one of the double ladders is disabled. In some dredgers with double ladders, a cross-shoot has been fixed to overcome this difficulty; but either this shoot must be at too flat an angle to carry off the material by gravitation, or the regular shoots are at too great an angle. As the ladder in a double dredger is nearer to the side of the hull than a single one, it can work nearer to a dock or quay-wall; but the difficulty of discharging still remains. This is partially met by working the dredger at an angle to the wall, when it is then possible to get in a small hopper-barge between the dredger and the wall; and if the ladder is well forward, or projecting at the ends, the dredging can be carried on close to the foot of the wall.

Single-ladder dredgers have been constructed with the ladder overhanging one side, so as to be able to work close to a wall; but there is not much gained by this arrangement, for it necessitates the raising of the shoot, to enable it to pass the material over the vessel to the mud barge, and consequently increases the height of the top tumbler.

If the material to be dredged is very stiff, it is possible the double dredger may have an advantage over the single one; for if the tumbler can be arranged so that the two buckets shall not be doing their heaviest work simultaneously, the power required to work two smaller buckets would probably be less than that required to work one of equal capacity to the two. The friction, however, would be greater with the two ladders, and might possibly outweigh any other advantage. For heavy work, double dredgers are certainly preferable; on the Tyne and elsewhere there are double dredgers working with buckets of 14 to 16 cu. ft. capacity; and buckets of twice this capacity would be very unwieldy.

Hull of Dredger.—The form of the hull is dependent almost entirely upon the conditions of working the dredger. It may have to pass through a narrow dock entrance, or other opening, or it may have to work in a seaway; a narrow dredger would be required in one case, and a wide one in the other; and these two considerations affect the depth. The length of the dredger is dependent, in a great measure, upon the length of the ladder; though it may be constructed with an overhanging gallows. The strength of the frames, plating etc., is of course dependent upon the work the dredger has to perform. In double-ladder dredgers, the ladder, in some cases, works clear on the outside; but in others, it works in a well. With the former plan, it is perhaps possible to dredge nearer to a wall, and the barges can get a little nearer to the shoots; but with the well, the vessel is decidedly more stable, and the ladders receive additional support when dredging either radially as in an open seaway, or sideways as in a dock. With very long ladders, the forward end of the well has to be open, to allow the ladder to be drawn up; but as this plan is objectionable, in one or two instances the ladder has been made with a hinge, so as partially to double up and pass through. If the dredger has to cut its own channel, as is often the case, the ladder must project beyond the bow of the vessel; and with this object in view a very novel arrangement has been devised and adopted by several makers, notably Messrs. W. SIMONS & Co. of Renfrew, and Messrs. FLEMING & FERGUSON of Paisley, whereby the top tumbler and bucket-ladder is constructed to traverse fore and aft on the upper framing, the bevel pinion driving the tumbler shaft working on a feather key; by this arrangement the bottom end of the ladder can be brought a long distance in front of the dredger, thus enabling the channel to be dredged in advance.

Engine and Boilers.—The high-pressure compound marine engine and boiler gives very good results, and is now generally used. As the work of a dredger is very variable, it is very necessary to have an efficient automatic expansion-valve; and what is of more importance still, a very heavy fly-wheel. By referring to the indicator diagram of No. 4a dredger (Plate 3, Fig. 10), the advantage of this is evident. The indicator diagram was taken when the buckets and all the machinery were in gear, with the ladder out of the water; and consequently the work being done was perfectly uniform, and there should have been only one line on the card. The indicated oscillation of the pencil was due to the governor balls being made too light; and had it not been for the action of a heavy fly-wheel, damage would no doubt have been done to the gearing. After this card had been taken, the governor was weighted, and a diagram with a steady line was then obtained. The suction-pipe for the circulating and feed pumps should not be taken from the well, which is conveniently situated, but from the after-end of the vessel, the water being there much clearer than that in the well, on account of being farther away from the buckets. It is very necessary to have convenient indicator-gear fixed to the engines, and that cards should be periodically taken to ascertain the condition of the cylinders and valves.

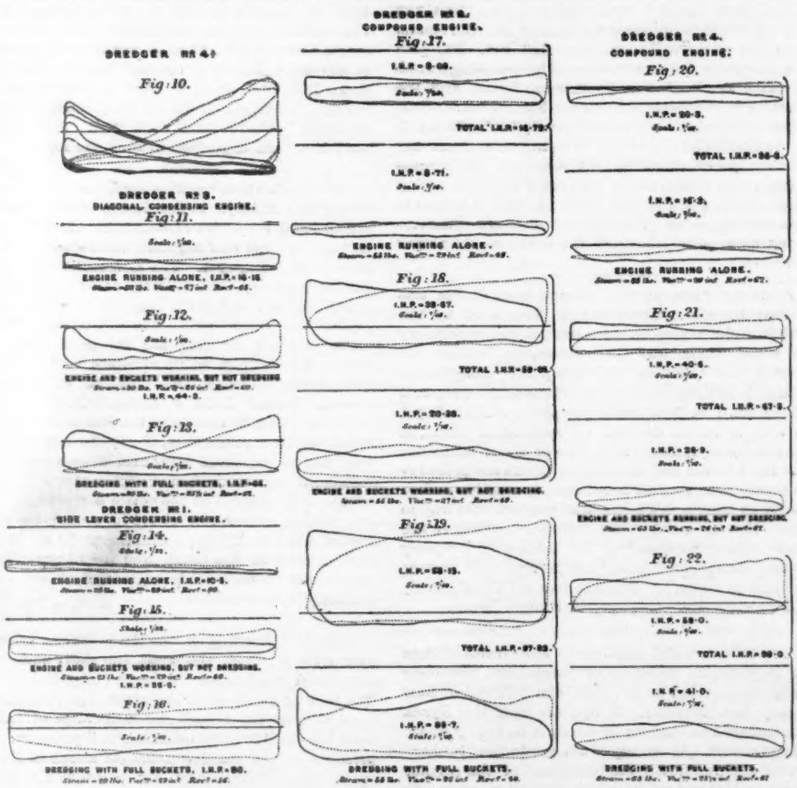


Plate III.

Driving and hoisting gear.—The top tumbler is driven from the main engine, either by means of spur-gearing or by a countershaft and bevel gearing, the latter making the most convenient arrangement. This gearing should be thrown in and out of gear by means of a friction-clutch, so as to take the strain gradually; and, addition to this, there should be a safety friction-clutch for each tumbler, so adjusted, that when an abnormal strain comes on the buckets, as when fouling wreckage, etc., the clutch will slip, and prevent an accident to some part of the machinery.

For driving the hoisting gear of the ladders, separate engines are sometimes used; but generally a countershaft is taken from the main engine. This latter plan has many advantages; and although it entails the constant running of a shaft which is only used occasionally, it is a very satisfactory arrangement. The master of the dredger has to keep a constant look out upon his buckets; and by the quantity of material in them, he can tell whether to raise or lower his ladder. In either case, he has to release the brake first; and this action has caused more damage to the hoisting gear than almost anything else, for it is almost impossible to release the brake and then commence hoisting immediately. The consequence is, that either the hoisting gear is put into gear with the brake on, or the brake is released first, and the ladder gains considerable impetus before it is checked. In each case there is a sudden check on the gearing, which is often very disastrous. This difficulty, however, is overcome by the adoption of a differental brake, such as Napier's, which the author has successfully applied on many dredgers (Plate 4, Fig. 2), where the power applied is the difference of the lengths of the arms *A B*, and *A C*, into the length of the arm of the power. This power is so enormous that scarcely any weight is required for the strap to clip the drum, and it is in fact self-acting. On the other hand, the power the other way is decreased in the same ratio; so when the lifting power is applied, the brake immediately releases itself. By the use of this brake for the hoisting gear of a dredger, the lifting power can be applied with the brake on, so the man in charge has only one handle to manipulate at once; and as soon as the hoisting stops, and the ladder attempts to fall, the strap immediately grips the drum automatically. With this arrangement, it is very convenient to have the hoisting gear driven direct from the main engine, as it is quicker in its action than having to start a pair of steam cylinders, and it does not require the same care and attention, and is much less costly.

In the case of the bow and stern winches for working the side, head, and fall chains, it is preferable to have separate engines; for they have always to be working with a varying power and varying speed, which could not well be regulated if worked from the main engine.

Top and Bottom Tumblers.—The top tumbler is generally made either square or pentagonal in section; and as this tumbler transmits the power to the buckets, it is advisable to have it as small as practicable, so as to reduce the amount of the intermediate gearing. For this reason the square section has an advantage;

1 Transactions Inst. C. E. vol. I. p. 8.

2 The following is an abstract from "Sykes Local Record" of 1833: "October, 1811.—A very curious machine, for cleansing and deepening Sunderland harbor, was set to work. A steam-engine of great power was erected upon a floating barge, which continually drove round a number of iron buckets fastened to a chain, which filled themselves with sand and gravel at the bottom of the harbor, and successively emptied themselves at the top of the shaft into a spout ready to receive them. This machine could lift 55 tons of ballast in thirty-five minutes."

but there are other more weighty reasons why this form should not be adopted. In the first place, it necessitates the use of a "hunting-link" in the chain, to prevent uneven wearing of the tumbler by the buckets always coming on the same two faces. In the next place, there is an unnecessary loss of power in raising each bucket, on passing over the tumbler, a height equal to the difference between the side and diagonal of the square; and the falling of the bucket this distance on the tumbler causes unnecessary wear and tear. The nearer the surface approaches a circle, the less these evils become; but as the length of the sides of the tumbler are at present governed by the size of the buckets, it would be impracticable to have more than five or six sides; and even with six sides, there would be a danger of there not being sufficient grip and the tumbler slipping. This objection might possibly be overcome by using much shorter links than those at present adopted, and allowing the buckets to be suspended between, so as not to touch the tumbler in passing over it.

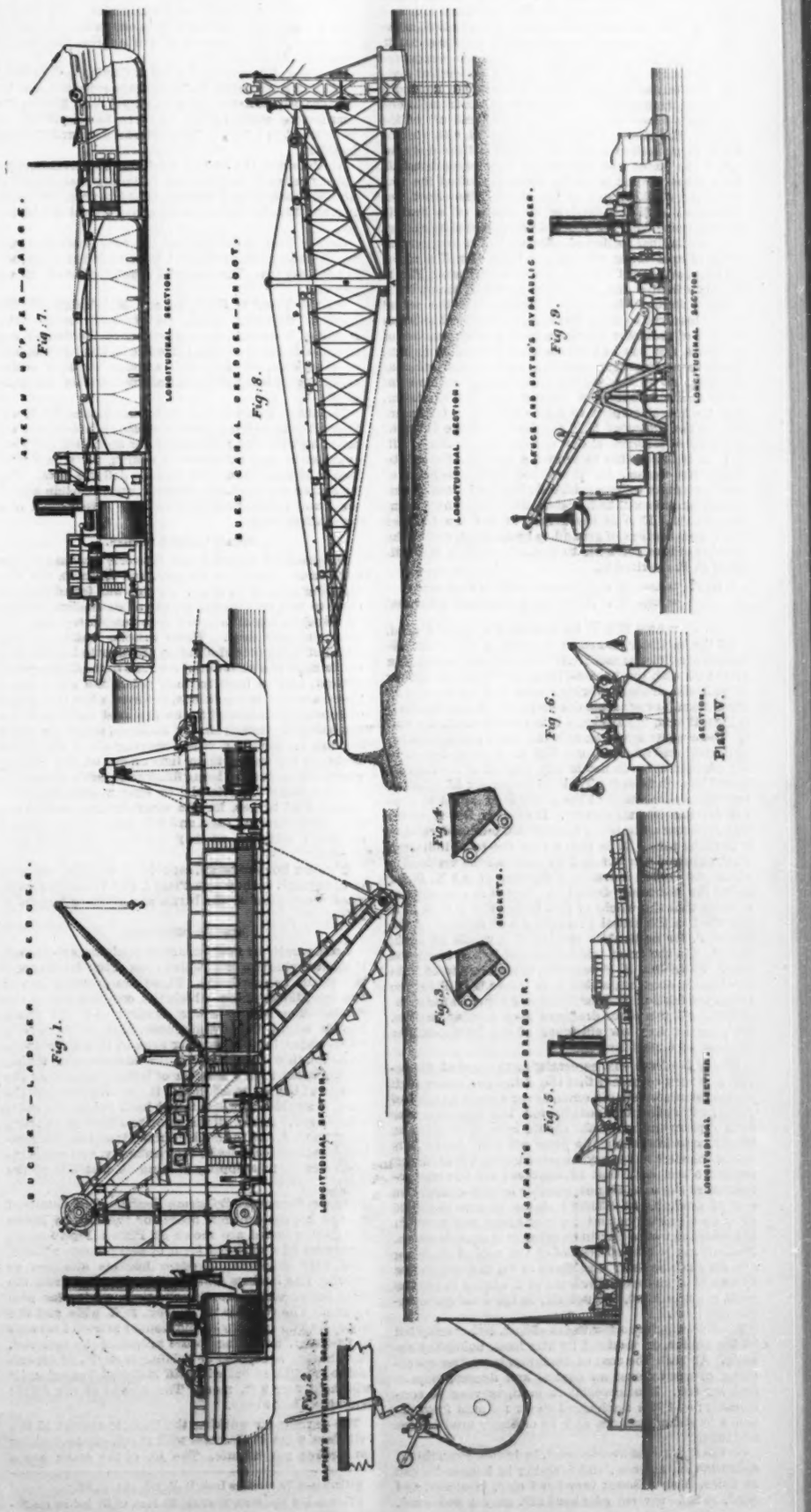
The top tumbler has to withstand great wear and tear, and has to be made of great strength in consequence. It should be made either wholly of cast-steel, or with chilled cast-iron faces, the latter plan giving very satisfactory results. With either material, it is very advisable to have loose corner pieces, for it is at his point that the greatest wear takes place; they must, however, be firmly secured by dovetailing them into the body of the tumbler, otherwise they would soon shake loose.

The bottom tumbler should have not less than six or seven sides; for as the power is not transmitted through its shaft, the larger the diameter of the tumbler the less will be the friction. This tumbler has generally large flanges cast on it to guide the buckets; they should not be circular, as is often the case, but of the same form as the body of the tumbler; otherwise the excessive depth at the center of a face offers unnecessary resistance when side dredging, and in stiff material prevents the buckets from being properly filled. This tumbler should also have cast-steel or chilled cast-iron faces.

Buckets, Links and Pins.—The buckets should not only excavate the material, but should also be able to discharge it readily into the shoots. This latter condition is very often not considered, and consequently, with stiff clay, the buckets fail to discharge their contents into the shoot; and it is necessary to have a man at the top, with a pricker, to help the buckets to be cleared. A large bucket has an advantage in this respect, for the surface adhesion varies as the square, whereas the contents vary as the cube. The fault generally lies in making the bucket with parallel sides; but, to enable the clay to pass out freely, the longitudinal section, both vertically and horizontally, should be tapered. Another fault consists in carrying the mouthpiece too far forward (Plate 4, Fig. 3), when, if soft material is being dredged, the bucket cannot possibly be filled; but if it be put further back (Plate 4, Fig. 4), a full bucket can be carried to the top. The latter form is also better adapted for discharging stiff material.

The buckets were formerly made of wrought-iron, either welded solid, or with plates riveted together; the double links, which were either of forged iron, or of malleable cast-iron, being riveted to the back. They are now made wholly of steel, the jaws for receiving the links being cast in one with the back, and having flanges at the sides and bottom for receiving the fronts. Thick steel mouthpieces are also riveted to the fronts, tapering from the main cutting-edge to the back. A number of holes should be punched all over the front to allow any water to get away. The links may be made of wrought-iron, or of steel; but, in either case, they should be bushed with steel, the bush being either driven in, or the eye of the link shrunk on, to prevent it from turning. The pin should be of large diameter; for a bucket of about 6 cu. ft. capacity, it should be not less than 3 ins. in diameter, and of steel hardened on the working surface. It should have either a square or triangular head, which is let into the bucket back, thus preventing any wear in the eyes of the bucket by turning. The pins should be turned round periodically so as to present a different working face alternately, thus ensuring uniformity of wearing; the life of a pin is from 12 to 18 months, according to the nature of the material dredged. For dredging in stiff clay with boulders, it is advisable to have strong prickers fixed at intervals on the chain, for removing or loosening the boulders.

Shoots.—The angle of the shoots is entirely dependent upon the nature of the material to be dredged; and this angle, in conjunction with the point of discharge, determines the height of the top tumbler. The following are found from experience to be the best angles for the different materials: for soft mud, 1 in 10; soft clay, 1 in 12 to 14; hard clay, 1 in 14 to 18; and fine sand and water, 1 in 20 to 25. It is very advisable to have a strong force-pump delivery-pipe near the shoot to clear it, and to assist any material that might stick. The shoots should be well covered in, to prevent splashing on the deck



In constructing the Suez canal, most of the dredged material was placed upon the banks; and as the canal was increased in width, very long and special shoots were required, designed by Mr. LAVALLEY (Plate 4, Fig. 8). The top tumbler of the dredger was 48 ft. above the level of the water; and the shoot itself was 230 ft. long. The framing carrying the shoot was supported on a separate barge *A*, which carried the central pivot *B*. This center could be raised or lowered by hydraulic pressure, to regulate the fall and facilitate transit; and the whole shoot could be turned fore and aft of the vessel. The shoot, *C*, was semi-elliptical, 5 ft. wide by 2½ ft. deep; and, to assist the delivery of the material when the shoot was very flat, a continuous band *D*, with rakes worked from the dredger, pushed the material the whole length of the shoot. The shoot was connected with the dredger by means of a flexible leathern pipe, and was moored and adjusted by chains.

A longitudinal section of a double-ladder dredger, capable of excavating 450 tons per hour of stiff mud, or 600 tons per hour of soft silt, is shown on Plate 4, Fig. 1; and its principal dimensions are given in Appendix I.

Power Required to Dredge.—To ascertain the actual power required to work dredgers, the author has taken a series of indicator diagrams from a large number of dredgers, and has had others kindly supplied to him. From these diagrams, and from observations taken at the time, as to the quality and quantity of material being dredged, height of delivery, depth of dredging, etc., he has attempted to frame a formula for ascertaining the indicated H. P. required to dredge different qualities of material under varying conditions of lift, etc. It is impossible to deduce a formula that will be absolutely correct, for there are such a number of varying factors to be considered; but the following empirical formula will be found to give sufficiently accurate results. If *H* is the height of the top tumbler shaft from surface of ground to be dredged, and *W* the number of tons per hour to be dredged, then the indicated H. P. required is,

I. H. P. $= 0.04\ W\sqrt{H}$ for very stiff clay or mud:
$= 0.034\ W\sqrt{H}$ for hard clay and indurated mud;
$= 0.026\ W\sqrt{H}$ for soft mud and light sand.

All the indicator diagrams were taken under the following conditions; namely, (1) with the engine running alone: (2) with the buckets in gear but not dredging; (3) with the dredger working with full buckets. The cards from four separate dredgers are shown on Plate 3, Figs. 11 to 22, the dredgers being numbered 1, 2, 3, and 4. These cards are taken as being fairly representative of the lot: and although most of them show defects in the engines, they do not in any way affect the results. It will be seen from the Table in Appendix II. what an enormous percentage of the power is absorbed in simply driving the machinery. If dredger No. 2, which was dredging 450 tons per hour of stiff mud and raising it 40 ft., be taken, it is found that the total indicated H. P. required was 97.8, and for working the machinery about 59.0; which leaves a difference of 38.8 H. P. for doing the necessary dredging. Now it is not right to assume that the whole of this balance of 38.8 H. P. is absorbed in the actual excavating and raising of the material, for no doubt a portion of it would be again absorbed in the extra friction caused by the increased load. The actual H. P. required to raise 450 to 40 ft. in one hour is about 21; which thus leaves 17 H. P. for the increased friction, and for the power required for excavating. All the other dredgers give similar results, showing the very low efficiency of the bucket-ladder dredger as a machine.

Cost of Dredging.—In ascertaining the cost of dredging, it is very necessary that the data upon which such cost is calculated should extend over a large number of years; otherwise, it is possible that the following year such repairs and renewals should have to be made as would materially raise the price per ton. Again, it is not of the slightest use comparing the cost of dredging at one place, with that at another; for the circumstances of the case cannot possibly be the same. The cost of dredging at different places is very useful to have as a guide; but all the conditions under which the machine works should be taken into consideration. Many of the published results of the cost of dredging are very misleading; and there is an inclination for advocates of any special scheme of dredging to put the costs at a minimum, and possibly to leave out some important item.

The following are a few items of cost, either supplied to the author, or obtained by him from published results. At Hull, the cost of dredging, including everything except interest on capital and depreciation, is 2.1*d.* per ton. The material is mud, varying in consistency; and it is discharged about 1¼ mile from the docks by steam hoppers, and by ordinary mud barges and tugs.

On the Clyde,[3] the average cost, including everything, depreciation, interest, and carrying in hopper-barges 27 miles, is as follows: very hard clay, boulders, and sand, 30.15*d.* per cu. yd.; hard silt, gravel and sand, 24.17*d.*; silt, clay and sand, 8.49*d.*; silt, gravel, sand, clay and mud, 8.08*d.*; and silt and sand, 7.94*d.* per cu. yd.

On the Tyne, the cost varies from 2*d.* to 6½*d.* per ton, according to the nature of the material. One dredger has dredged over 1,000,000 tons in one year, and including discharging a distance of 17 or 18 miles, the cost per ton was a little over 3½*d.*

The cost of removing the bar at Carlingford Lough,[4] including everything, Parliamentary expenses and insurance of plant, was about 1*s.* 9*d.* per ton. Taking the cost for one season, it was 1*s.* 4*d.* to 1*s.* 5*d.* per ton, or 2*s.* to 2*s.* 3*d.* per cu. yd. The material was hard clay and boulders.

At Aberdeen, the cost of dredging and transporting about 2 miles beyond the bar, including insurance, but not depreciation and interest, is 1.3*d.* per ton for dredging, and 2.9*d.* for discharging; giving a total of 4.1*d.* per ton.

On the Wear at Sunderland, the total cost of dredging, including everything but depreciation and interest is 2.37*d.* per ton. The material consists of sand, gravel and clay.

On the Tees,[5] at Stockton and Middlesbrough, the cost of dredging sand, gravel and occasionally boulders, including the conveyance of the deposit out to sea, a distance of about 12 miles, is 4.96*d.* per cu. yd., or about 2½*d.* per ton. This amount includes everything except interest of capital expended on dredging plant.

The above prices are all for bucket-ladder dredgers; the author has been unable to obtain reliable prices for dredging with other apparatus, for they have not been engaged in any extensive operation for a sufficient length of time to furnish reliable definite data. The bucket, or dip dredgers, however, under certain conditions and circumstances, give very satisfactory and economical results.

STEAM HOPPER-BARGES.

The dredged material was formerly discharged into small mud barges, or lighters, and taken to the discharging ground by a tug. As this was found in most cases to be a very inconvenient and expensive method of disposal, steam hoppers were introduced, and are now generally used. These vessels, unlike a long string of lighters behind a tug, are easy to handle, and can in most cases get out of dock, go to the discharging ground, and be back in dock before the gates close. There are certain conditions, however, when it is found to be more economical to tow the mud lighters to the discharging ground; as, for instance, when the same tug can be used for either moving ships about the docks, or for towing them into or out of the harbor, whilst the barges are being filled or possibly lying idle. In any case it is advisable to have a number of ordinary mud barges, for the steam hopper-barges are also very powerful tugs, and will take in tow almost as much material as they can carry in their own hopper.

A steam hopper-barge, capable of carrying 500 tons of dredgings, is shown on Plate 4, Fig. 7; and the principal dimensions of the barge are given in Appendix III.

HOPPER-DREDGERS.

A comparatively new feature in dredging appliances, is the introduction of a combination of the dredger and the steam hopper-barge. There are probably one or two conditions under which the combination of the cumbersome bucket-ladder dredger and the steam hopper might be advantageous, such as for outside work where the discharging ground is not far away. In docks, they certainly have the advantage of taking up less room than a number of lighters attending the dredgers; but in most cases, if the dredger left the dock, it would not be able to get back before the gates were closed. Again, all the moorings have to be taken up or buoyed, and the ladder shipped; and such a cumbersome machine must be very unhandy, and cause inconvenience to shipping passing in and out of the dock.

Hopper-Barge with Priestman Buckets.—The details of a large hopper-dredger, made for the Mersey Docks and Harbor Board, are shown on Plate 4, Figs. 5 and 6. It consists of a modified form of steam hopper-barge, with four Priestman dredger buckets attached as shown. The buckets are supplied with steam from the same boiler which supplies the main engine for propelling. The vessel is 195 ft. long, 35 ft. wide, and 15½ ft. deep. The capacity of the hopper is from 1,000 tons to 1,200 tons, according to the nature of the material. Each bucket is capable of holding 36 cu. ft. of deposit inside the plates; but with stiff material, heaped up, it will hold 6 or 8 ft. more. The weight of the empty bucket is 1 ton, 9 cwts.

The engines for working the buckets consist of two cylinders, 9 ins. in diameter with 12 ins. stroke, making 130 strokes per minute. The jib of the crane has a radius of 14 ft.; and the bucket is arranged to dredge to a depth of 34 ft. below the water-line. The bucket is raised, when full, at a speed of 80 ft. per minute. Each bucket is capable of making from sixty to sixty-five lifts per hour, but sixty lifts per hour is considered very good work. When there is plenty of mud, the hopper can be filled in three and-a-half to four hours; but when the mud is scarce, it takes from five to six hours to fill. About two tons of coal are consumed in filling the hopper, and another ton is consumed in taking the hopper to the discharging ground, about 8 miles away, and back again. The average time taken to discharge the material is from three to four hours, this time depending of course entirely upon the wind and tide; the quickest time in which it has ever been done is 2 hours, and 40 minutes, everything being favorable. The ordinary hopper-barges do it in a little less time, because, on account of their lighter draught, they have not the same distance to travel.

The number of men required to work these hopper-dredgers is twenty-one; viz., a captain, a landing captain, a mate, a chief engineer, a second engineer, a third engineer, four crane men, four firemen, and seven sailors.

Bruce and Batho's Hydraulic Dredger.—Messrs. Bruce and Batho have designed a novel dredger, consisting of one of their buckets already described, but worked entirely by hydraulic power. The dredger of this design was made for working on the Tyne, and is shown in Plate 4, Fig. 9. The excavator, or dredger, *A*, is fixed to the end of a beam which is actuated by two hydraulic cylinders, one, *B*, being used for raising the bucket, and the other, *C*, for lowering it, the hydraulic power being supplied from the pumps in the engine-room. The bucket is opened and closed by means of the hydraulic cylinder *D*. A novelty in the design is the ingenious way in which the lever, in ascending draws the shoot under the bucket to receive its contents, and draws it away again as the bucket descends. The hydraulic cylinder at the end of the beam is carried on gimballs, to allow for the irregularities of the surface being dredged. The hydraulic pressure is 700 lbs. per sq. in.; and as it is not advisable to have the pressure from the pumps taken direct to the cylinder, the water is pumped into a steam accumulator.[6]

GENERAL REMARKS.

In describing in this paper the many varieties of dredging appliances now in use, the author has not in any way attempted to advocate or depreciate any particular class; for it is obvious that the form of dredger to be selected for any special work depends entirely upon the nature of the material to be excavated, its depth below the surface, the site, and other physical and local conditions, each dredger having its own special merits and advantages when dealing with the work for which it was designed. When comparing any results with the object of obtaining reliable deductions, it is very necessary that all the conditions under which the experiments were made should be identical. Now with a dredger, it is almost impossible to obtain such conditions, for it would require a small fleet of dredgers, each one varying from the other in one particular only, such as the form of buckets or tumblers, and a uniform depth and consistency of material to be dredged, etc. It is possible, however, to make one or two general deductions which may have a practical value.

The sand pumps, such as were in use at the Amsterdam Ship-Canal, Lowestoft, Oakland Harbor, and other places, gave most satisfactory results; and, judging from the nature of the material and other local considerations, it is evident they were the best appliances to be used under the circumstances. The disadvantage of all sand-pumps is that in addition to lifting the sand or mud, they have to take up a large proportion of water; this means not only an extravagant expenditure of power in the pumps, but also in the hopper barges; for in most cases the mud is of such a nature that it cannot possibly settle before being discharged, and consequently a large proportion of the water is carried out to sea in the hoppers. Sand-pumps have, however, the advantage of reducing the height of the lift of the material to a minimum, the discharge-pipe being capable of being placed at the level of the hopper gunwales if necessary; and by the use of telescopic suction-pipes, they can be made quite independent of the variation of the water-level due to the tide or waves.

The dip or bucket dredgers of the clam-shell type are very convenient for working in confined places, such as the corners of docks, and behind dock-gates, and are specially suited for canal work, where they can, if necessary, be worked from the bank so as not to interfere with the traffic. This class of dredger has the same advantages as the sand-pump with regard to the height of lift, and working in a tideway or rough water. The wear and tear, especially of the closing chains and

3 Minutes of Proceedings Inst. C. E. vol. xxxvi p. 169.

4 Minutes of Proceedings Inst. C .E. vol. xliv. p. 135.

5 Evidence of Mr. JOHN FOWLER, M. Inst. C. E., before the Select Committee of the House of Commons on the Manchester Ship Canal Bill, 1885.

6 The following are the leading dimensions of the dredger now working, and shown on Plate 4, Fig. 9:—Length of vessels, 80 ft.; beam, 18 ft.; depth, 6 ft.; draught, 3 ft.; diameter of excavator 6 ft.; depth to dredge, 15 ft.; and four men required to work the dredger.

the mouthpieces, is rather severe. A large number of these dredgers are now working very successfully in different countries; but for regular heavy work, such as is undertaken by the bucket-ladder dredgers, with the exception of the large dredger now working in Liverpool fitted with four of Priestman's buckets, they have not been tried on any extensive scale; and although this dredger promises to give most satisfactory results, it has not been working a sufficient length of time for a definite opinion to be given.

For steady heavy work, the bucket-ladder dredger is undoubtedly well adapted; in fairly smooth water it will do its work well, uniformly, and comparatively cheaply. It cannot, however, work in shallow water, or if there is much oscillation of the boat from the effects of rough water or a swell. Although this dredger gives apparently such satisfactory results, in watching it working it is impossible to help being struck with the very small amount of material being gradually tumbled out of such an immense structure; and by referring to the indicator diagrams (Plate 3, Figs. 11 to 22) and the Table in Appendix II, it is evident that there is great room for improvement somewhere in the design.

One source of waste of power in the bucket-ladder dredger is in having to lift the material about 24 ft. above the water-line, when it is only actually required to be lifted over the gunwales of the mud lighter. So long as the material is discharged by retarded gravitation from the top tumbler to the hopper this objection cannot be removed; the hopper dredger however, has a slight advantage on account of the center of the hopper being nearer to that of the tumbler. The author is of opinion that certain advantages would be gained if the material was discharged at a lower level into a trough, and carried to the hoppers by horizontal helical creepers. By this means, the weight of the framework would be greatly reduced; the tumbler shaft would be nearer the engine, thus reducing the amount of intermediate gearing; the length and weight of the ladder, and the number of buckets and links, would be greatly diminished; the dredged material could be discharged on either side of the vessel; and by a proper arrangement of doors at the bottom of the creeper, extra facilities would be offered for distributing and discharging the material.

By referring to the indicator-diagrams, it is seen what an enormous percentage of the power is expended in simply driving the machinery: and from the table it appears that this loss of power increases with the size of the buckets, which naturally follows from the increased weight of the buckets and links. The greater portion of the power is absorbed in dragging the buckets and links round the bottom tumbler, and often also owing to the bad arrangement of the rollers on the top of the ladder. The advisability of having the bottom tumblers as large as possible, and the carrier rollers at short intervals is at once apparent; and the author is of opinion that if the bottom tumblers were to receive assistance from the engine, more economical results would be obtained.

A very important matter in connection with dredgers, as well as all classes of machinery, is the careful preparation of complete plans and comprehensive specifications when any machine is required. This is expedient both for the engineer and the contractor; for as such work is generally submitted for competitive tenders, unless all the contractors have the same definite data to work from, there is a great temptation to put in inferior designs and workmanship to ensure being at the bottom of the list, and unfortunately, as a rule, having the work to carry out. It is quite a mistake to leave too much to a contractor, who may have any speciality. The engineer is the person who should know best what is needed for his own work; and if he has his plans and specifications prepared accordingly, it is his own fault if he does not then get what he requires.

The paper is accompanied by drawings, from which the plates have been engraved.

APPENDIX I.

DOUBLE-LADDER DREDGER.

(Plate 4, Fig. 1.)

	Ft.	Ins.
Extreme length	126	0
" breadth	32	0
Height from underside of floors to top of deck amidship	10	3
Draught in working trim	6	6
Depth to which dredger will work	28	0
Sheer fore and aft	0	9
Crop of deck	0	6
Height of top tumbler shaft from water-line	23	0
Width of bucket wells	4	6
" " " where swelled at ends	6	0
Frames, 4 in. by 3 in. by $\frac{7}{16}$-inch angle-iron, 2 ft. apart.		
Plating of bottom and bilges	$\frac{1}{2}$ inch.	
" sides	$\frac{7}{16}$ "	
" wells	$\frac{1}{2}$ "	
Deck beams	6 in. by $\frac{1}{2}$ "	
Floors, 12 in. deep by $\frac{1}{2}$ in. with angle-irons 2½ in. by 2½ in. by $\frac{7}{16}$ in.		
Length of bucket-ladder between centers	72 ft.	
Capacity of bucket	8 cu. ft.	
Diameter of pins	3 in.	
Engines, compound—		
High-pressure cylinder.	19 in. diameter by 24 in. stroke	
Low " "	34 " " by 24 " "	
Air-pump	16 " " by 15 " "	
Circulating pump	8 " " by 15 " "	
Boiler diameter	10 ft.	
" length	9 ft. 6 in.	
" heating surface	8,002 ft.	
" working pressure	55 lbs.	
Cost	£14,000	

APPENDIX II.

No. of Dredger.	No. 1.	No. 2.	No. 3.	No. 4.
Kind of ladder.	Double.	Double.	Double.	Single.
Capacity of buck't in cu. ft	4½	6	10	14
Class of engine.	Side-lever—jet-condenser.	Compound—surface-condenser.	Diag'nal—surface condenser.	Compound—surface condenser.
Diameter of cylinders	30 ins.	19 ins and 34 ins	33 ins.	21¼ ins & 40 ins
Stroke	36 "	24 ins.	36 "	30 ins.
Steam pressure in lbs. pr. sq. in	15 to 17	55	32	65
Nature of material dredg'd.	Very s'ff m'd	S'iff mud	So't mud	Clay.
Tons dredged per hour	300	450	400	450
Height of top tumbler from surface of ground	43 ft.	40 ft.	43 ft.	41 ft.
(a) I. H. P., engine running empty	10·5	16·79	16·16	36·6
(b) I.H.P., buckets in gear, but not dredging	35·5	39·65	44·17	67·5
(c) I.H.P., dr'dging with full buckets	80·0	97·83	66·0	99·0
I.H.P. absorbed in excavating and rais'g the mat'rial = difference of (b) and (c)	44·5	38·78	21·83	31·5
Percentage of tot'l I.H.P. absorbed by friction	44·4	60·6	68·0	68·5

When dredger No. 1 was in full gear the engine was driving, in addition to the tumblers, the gear for lifting the ladders, and also the winches for the head and side chains; the other three dredgers had separate engines for the head and side chains, the ladder lifting-gear being driven by countershafts from the main engines.

APPENDIX III.

STEAM HOPPER-BARGE.

(Plate 4, Fig. 7.)

	Ft.	Ins.
Length between perpendiculars	150	0
Breadth moulded	26	0
Depth from top of beam amidships to top of keel	12	4
Capacity of hopper to level of top of deck beams	500 tons	
Length of hopper	60	0
Breadth " top	20	6
" " bottom	8	10
Depth of hopper	12	0
Draught loaded, forward	10	9
" " aft	11	3
" light, forward	4	4
" " aft	8	7
Sheer " forward	2	8
" " aft	1	8
Plating garboard strake ½ length	0	$\frac{5}{8}$
" " " remainder	0	$\frac{7}{16}$
" sheer strake	0	½
" bottom " ½ length	0	½
" " " remainder	0	½
" bilges " ½ length	0	½
" " " remainder	0	½
Engines, compound—		
High-pressure cylinder.	20 in. diameter by 30 in. stroke	
Low " "	38 " " by 30 " "	
Air-pump	14 " " by 16 " "	
Circulating pump	9 " " by 15 " "	
Boiler	11½ feet " by 10 ft. long.	
" heating surface	1,250 sq. ft.	
" working pressure	70 lbs. per sq. in.	
Cost	£7,000	

Remarks on the "New Method of Dimensioning."

BY WM. CAIN, PROF. OF MATHEMATICS AND ENGINEERING, SO. CAROLINA MIL. ACADEMY.

(*Concluded from page 38*).

If we use Mr. OTTEWELL'S formula (A), $b = 5{,}000\ (1 + 2\,\theta)$ in place of $b = 7{,}500\ (1 + \theta)$ in the second member of eq. (8), we should similarly find,

TABLE II.

Span in feet.	θ	p_o	p
0	0	1·00	1·00
20	·1	·72	·80
70	·2	·52	·65
150	·3	·38	·56
250	·4	·29	·48
300	·5	·21	·42
400	·6	·15	·37
500	·7	·10	·33

The percentages added to live load given in the last column seem much too large for impact alone, and are not justified by observations on increased deflection due to velocity, to which I shall now appeal.

To recall again, however, the meaning of the quantities in the last column, let it be borne in mind, that, for a 150-ft. span, for example, if 56 per cent. of the live load is added to it, the total stress found and the section of a lower chord member computed by LAUNHARDT'S formula, the area will be the same as that obtained by using Mr. OTTEWELL'S formula (A) for unit stress when the percentage above is not added. So far, the stress in a lower chord member has, for simplicity, alone been considered. The same percentages apply in any case to the upper chord and to the end braces, since θ is nearly the same for chords and end braces; but for a counter $\theta = 0$, and the percentage is higher, amounting in Table I to 33⅓ per cent. of the live load; likewise the percentage for the main ties and posts is higher, varying from 33⅓ per cent. for middle ties to nearly the allowance for the chords in the end ties. This looks inconsistent at first sight; and yet if the formula gave the same percentage throughout the bridge for the superadded stress due to the live load in motion, it would be worthless; for the counters and middle ties are very small, and long members rattle more and are doubtless strained more from the motion of the train than the more stable chord members.

Formula (1) gives 7,500 lbs. per sq. in. for the counters and middle ties, which common practice has warranted, and the unit stress for the remaining ties, as determined by it, increases pretty regularly from the center to the ends, as it undoubtedly should.

The exception that is involved in the formula for ties and posts is thus a strong point in its favor, and it is doubtful if practical men would ever use it if it happened otherwise, for all we can hope from such empirical modifications of LAUNHARDT'S formula is to give results agreeable to the best judgment of practical engineers, aided by experiment when possible.

We shall now proceed to some experiments, giving the increased deflection due to the *motion* of the train over bridges of different span, which we can compare directly with the results given in the last columns of Tables I and II, since these percentages p, giving the superadded stress, may be taken roughly as the measure of the superadded deflection, which, however, should be something more, to allow for the increased stresses in the web members mentioned above.

STONEY ("Strains in Girders", Chap. 25) gives the following account of some experiments:

"1. A small carriage loaded to 1,120 lbs. was placed at rest upon a pair of cast-iron bars, 9 ft. long, 4 ins. broad and 1½ ins. deep, when the deflection was $\frac{5}{8}$ of an in.; but when the carriage passed over the bars at ten miles per hour, the deflection was $\frac{7}{8}$ in., and at 30 miles per hour, 1½ ins., or more than double the statical deflection.

Since $\theta = 0$, p is something over unity, so that from Table II, we see that Mr. OTTEWELL'S formula applies to this limiting case, as it should, since the bars were subjected to nearly the same treatment as the moving parts of a machine.

It also appeared that when motion was given to the load, the points of greatest deflection and still more of the greatest strains, did not remain in the center of the bars, but were removed nearer to the remote extremity of the bar. The bars, when broken by a travelling load, were always fractured at points beyond their centers, and often broken into four or five pieces, thus indicating the great and unusual strains they had been subjected to.

2. An engine and tender were run across a cast-iron girder of 30 ft. span (two tracks), at velocities of 0, 15, 27 and 50 miles per hour, the corresponding deflections being .19, .23, .22 and .25 of an inch. At 15 and 27 miles, the deflection was thus ¼ more, and at 50 miles per hour ⅓ more.

The weight of one-half the bridge is 25 tons and of engine and tender 33 tons. If three-fourths of this, say, goes to the nearest girder, the value of $\theta = \frac{24}{110} = \frac{1}{5}$, which corresponds to $p = .18$ in Table I. If the deflection above was that of the girder nearest the engine, we see that Table I corresponds to the velocity of, say, 30 miles per hour.

3. The span of the Ewell bridge is 48 ft., the dead weight of one-half is 30 tons and the statical deflection due to an engine and tender weighing 39 tons was rather more than $\frac{1}{8}$ in. This was slightly but decidedly increased when the engine was made to pass over the bridge, and at a velocity of about 50 miles per hour an increase of one-seventh was observed.

It was probable that θ here was again ⅕, which gives in Table I, $p = .18$, or slightly over ¼, so that the table allows for velocities slightly over 50 miles per hour for this bridge.

4. Mr. HAWKSHAW found for spans of 55 to 88 ft. that 'where the road is in good order the deflection is not much increased by speed;' but this, of course, refers to the very heavy English bridges.

5. Mr. STONEY found for the Boyne bridge, 264 ft. span, that the deflections at a very slow speed and at 50 miles per hour did not differ by the width of a very fine pencil stroke.

6. Very different results, for spans of 128 to 189 ft., have been found for the open web bridges of this country, due to the very thorough experimental researches of Prof. S. W. ROBINSON, which are detailed in the Transactions of the American Society of Civil Engineers for February, 1887. There were 13 bridges examined, and the increased deflection due to the motion for passenger and freight trains, at usual speeds, varied all the way from almost nothing to 28 per cent. out of 193 train transits observed, 25 gave unusually large superadded deflections, averaging 18.4 per cent. The allowance for such spans by Table I, is about 22 per cent., which thus agrees sufficiently well with the average maxima. In some cases the percentage due to the cars added to the statical deflection due to cars, was greater that the deflection due to engine load principally."

The excess deflection and consequent stress due to the motion of the engine is mainly due to the unbalanced drivers, and if this could be got rid of too, and the track kept in perfect order, we should be enabled to save something in bridge construction.

Mr. ROBINSON proposes a formula for computing the excess load due to motion of non-balanced drivers which causes this excess to *increase* with the span, a result so at variance with all experience that I shall feel compelled to believe the contrary until it is absolutely proved by experiments upon every length of span. Table I or the use of formula (1), causes this excess deflection to decrease with the length of span; and it really looks as if the weak spot in the table (or the formula) was that this excess does not diminish rapidly enough as the span increases.

It will be very desirable for all engineers who may have kept records of deflections due to live loads at rest and in motion, to communicate them to this journal, so that a more intelligent appreciation of the proper percentage to use can be arrived at for all spans. The greatest variation will doubtless be found in the results, to judge from Prof. ROBINSON's observations, but still the matter can only be decided in this way.

Supposing we had very extended and complete observations on this point, we should thus progress a long ways towards eliminating that factor of ignorance, that WÖHLER'S researches first shed so much light on.

It must be borne in mind, however, that a factor of safety will always be needed to allow for actual defects and contingencies. It is tacitly assumed now-a-days by many that one can accurately compute the stresses in a bridge truss by ordinary methods, which is far from true.

The ordinary method leaves out the fact that the joints, from friction or rigidity, are not free to move; besides the reactions are not always vertical, and more than all, the upper chord is made continuous, which of itself changes all the stresses, all the more if the web members do not exactly fit. I have computed one or two roof trusses, regarding the continuity of the main rafters and find at certain points the stresses very different from those obtained on the theory of smooth joints, When we pass on to riveted lattice girders, swing bridges, etc., the incompleteness of ordinary methods is still more apparent; so that if we use approximate methods of computation, as is usual, we have to pay for it by so much more iron included in "a factor of safety," and this is unavoidable in those cases where some indetermination will always exist.

Is it not better *not* to make the upper chord a continuous member? The effect of the wind is now fairly well provided for in specifications, which cannot be said for the great majority of bridges already constructed; still there is some indetermination on this account, besides the effect of great cold, flaws, rust, bad material, bad workmanship and accidents must always be included in a factor of safety. Very shallow girders too are to be condemned, or any conditions favoring great vibrations.

It is evident though that as indetermination and hurtful influences are more and more eliminated we can raise the unit stresses and thus secure a better and a cheaper bridge.

As some question has been raised as to the correctness of the coefficient ⅓ of θ in LAUNHARDT'S formula (2), I have carefully re-examined WEYRAUCH and SPANGENBERG and find no warrant for raising it. LAUNHARDT seems to have got his coefficient ⅓ from experiments on flexure just as WEYRAUCH did, but for *direct tension*, the only values given of WÖHLER'S confirm the coefficient ⅓ for 10,000,000 repetitions. From SPANGENBERG'S Table 1, we might infer the same reason for 500,000 repetitions; but as the breaking strength is not given, we cannot say positively. It looks probable though that for a high grade of iron, this coefficient will be slightly raised, for LAUNHARDT and WEYRAUCH found ⅓ and ⅜ respectively, for hard steel (breaking strength 100,000 lbs.) though WEYRAUCH proposes $\frac{5}{11}$ for an 80,000 lbs. steel. As we have to guess at this factor for mild steel (say 60,000 to 70,000 lbs. breaking strength) we may as well include impact in the guess and write,

$$b = 8{,}000\,(1 + \tfrac{3}{4}\,\theta) \qquad (10)$$

for the safe strength in pounds per square inch, impact included, of links or rods of mild steel. [If we regard the effect of impact here, as represented by $4{,}000\,(1 - \theta)$, which gives the coefficient $\frac{3}{4}$ in the LAUNHARDT formula, we shall find the percentages p of Table 1 increased about one-third as an average. To be consistent, however, the same allowance for impact should be given in all cases for chord members, no matter what the material.] Mr. BENJ. BAKER, engineer of the Forth bridge, is at present conducting experiments upon repeated strains of iron and steel.

If he should find for bridge iron and steel the constants of LAUNHARDT'S and WEYRAUCH'S formulas, he would render the greatest service to engineers, but so far there is no indication that he is directing his attention specially in that direction. The question too, whether formulas for struts that fail by flexure should be treated for fatigue of metals, is an open one. It is the writer's opinion that if a strut is near breaking or buckling with a constant load, that repetitions of stress will insure its failure; but it may not be influenced in so marked a degree as ordinary tension bars for smaller loads. Still to be on the safe side, it seems well to so regard it.

The writer is glad to see the tendency towards the permanent retirement of the RANKINE formula for struts.

It is empirical in character and not so good for usual lengths as the proposed right line formulæ, nor can it compare for higher length ratios to the correct theoretical formula known as EULER'S. See an article by the writer in the Journal of the Franklin Institute for July, 1887, where the whole subject of columns is treated from a theoretical standpoint, and the practical formulas of Mr. THOS. H. JOHNSON (see Trans. Am. Soc. Eng. July, '86) recommended for practice.

For convenience, we shall group together here the formulæ proposed for unit stresses in pounds per square inch for both ties and struts.

WROUGHT-IRON.

For pieces subject to tension only or compression only $b = u\,(1 + \theta)$

For struts subject to flexure:

$$\text{For flat ends, } b = b\left(1 - \frac{1}{328}\,\frac{l}{r}\right)$$

$$\text{For one end hinged, } b_o = b\left(1 - \frac{1}{300}\,\frac{l}{r}\right)$$

$$\text{For both ends hinged, } b_o = b\left(1 - \frac{1}{267}\,\frac{l}{r}\right)$$

where $\frac{l}{r}$ = ratio of length to least radius of gyration of cross-section, both in inches.

The unit stress b in the first formula is the value b to be used in the other formulæ.

For best bar iron, $u = 7{,}500$.

Plates or shapes in tension, $u = 7{,}000$.

Rolled iron in compression, $u = 6{,}500$.

MILD STEEL, (carbon 0.12).

For tension or compression, $b = u\,(1 + \frac{3}{4}\,\theta)$.

$$\text{Struts, flat ends, } b_o = b\left(1 - \frac{1}{293}\,\frac{l}{r}\right),$$

$$\text{One pin end, } b_o = b\left(1 - \frac{1}{270}\,\frac{l}{r}\right),$$

$$\text{Two pin ends, } b_o = b\left(1 - \frac{1}{239}\,\frac{l}{r}\right);$$

Where for bar steel, $u = 8{,}000$.

Plates or shapes, $u = 7{,}000$.

The WEYRAUCH formula for alternate tension and compression gives, for the extremes, $\theta = 1$ and $\theta = 0$. We should obtain the same sections by computing the sections for the tension alone, and then for compression alone, and adding the results; but for intermediate values of θ the results are somewhat larger than by the latter method.

As impact would simply increase both extreme stresses somewhat. It will scarcely affect the term θ = ratio of extreme stresses of opposite kinds, the greatest of the two being placed in the denominator. Hence, we shall write with Mr. WILSON, for alternate stresses of opposite kinds, $b = u\,(1 - \frac{1}{2}\,\theta)$, where u has the values given above.

It seems to me that a concession to practical convenience could well be made in the case of bearing stress and shear on pins and rivets, as well as the bending stress on the extreme fibres of pins, by using the usual *constant* values; for the method of computing these stresses is confessedly rude and inexact, particularly as to rivets, which generally work by friction and rarely sustain compression or shear, though, of course, it is proper to design them upon the hypothesis that they do. On the supposition that maximum wind strains will be rarely experienced, the unit stresses in the lateral systems are universally made constant.

It may not be out of place to remark that a specification should state what position of the live load is held to give minimum stresses on a web member. Take a Pratt truss for example, and consider a tie whose top leans towards an approaching train. As the engine reaches it, it experiences its *minimum* which is still tension if the panel is not one that requires counters. But as the train rolls on, this tie never experiences its maximum stress, which would be caused by a train coming in the opposite direction. Again, consider a tie nearest the abutment that is farthest from the approaching train; it receives its maximum stress as the engine reaches it (the exact wheel at the foot of the tie is easily found) and its minimum as the rear end of the train leaves it. How shall we estimate θ? I have elsewhere taken the absolute minimum and maximum for trains moving in opposite directions, but I do not believe it is as correct as to take the least ratio for the train in a single passage across the bridge; for then the extremes of stress succeed each other most rapidly and possibly the conditions are more nearly those realized by WÖHLER in his experiments than on any other supposition. "The influences of rapidity of repetition, rapidity of increase of stress, and duration of individual stress have not been in

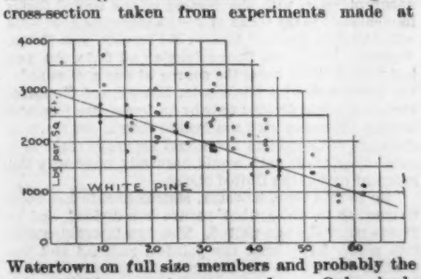
vestigated." and I have elsewhere suggested that a good practical rule for web members is to uniformly increase the unit stress on web members from the counter panels to the end of truss, though the computation by formula (1) will take but very little time.

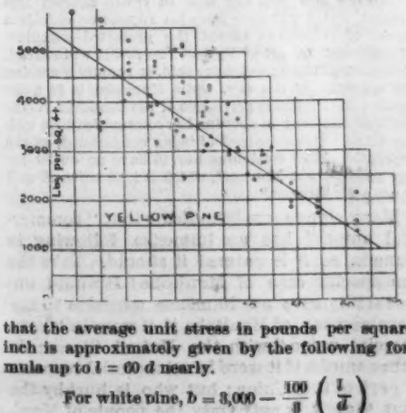
Although the methods of finding maximum stresses from wheel loads is now well known, it involves labor, and it is to be hoped that a method of equivalent panel loads with a locomotive excess can be devised to give practically the same results. There is too much uncertainty about strains to figure them down to a single pound.

In conclusion, the writer hopes that he has exposed the merits and demerits of the system proposed fairly, so that a more intelligent conclusion can be reached as to the advisability of applying it in practice, or if it is found wanting, of rejecting it.

APPENDIX.

Two diagrams are given below of the compressive strength of white and yellow pine posts of various ratios of length to least diameter of the rectangular cross-section taken from experiments made at Watertown on full size members and probably the only reliable experiments we have. Only single sticks were included. The account of the experiments is given in Executive Document 12, 47th Congress, 1st. Session. From the diagrams we see that the average unit stress in pounds per square inch is approximately given by the following formula up to $l = 60\,d$ nearly.





$$\text{For white pine, } b = 3{,}000 - \frac{100}{3}\left(\frac{l}{d}\right)$$

$$\text{For yellow pine, } b = 5{,}500 - \frac{200}{3}\left(\frac{l}{d}\right)$$

The minimum unit stresses are about 400 lbs. less with a few exceptions. Mr. JOHNSON found for oak posts, from some experiments by SAMANDE on seasoned oak, for flat ends

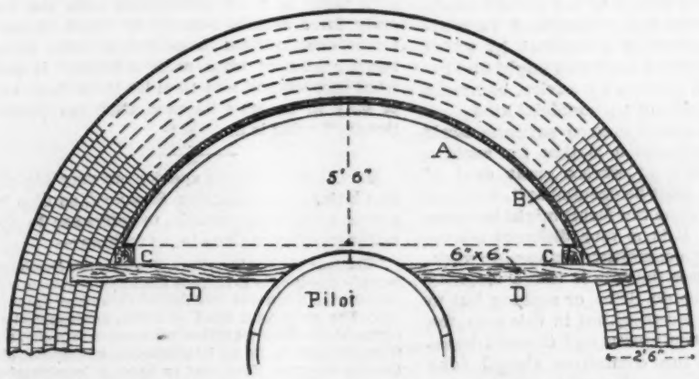
$$b = 5{,}400 - 28\frac{l}{r}$$

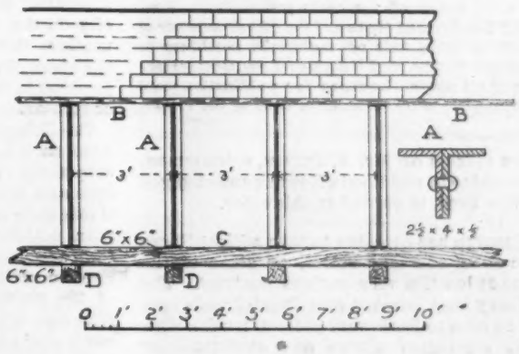
where l = length in inches and r = least radius of gyration in inches.

As the stress in practice is rarely so well distributed over the ends as in the experiments, we should use a factor of safety of at least 4 or 5 or more, especially where the framing is carelessly done or the timber is knotty or otherwise undesirable, as in very much trestle work that yearly goes up on our railroads.

The Centering in the Hudson River Tunnel.

The centering for the arch of the Hudson River tunnel which we illustrate herewith, possesses strength and rigidity, occupies no more space than is absolutely necessary, is extremely simple in construction, and can be easily set. The small space occupied is a most important qualification, especially when we consider how many struts there are radiating from the pilot to brace the shell of iron plate lining the interior of the excavation. It will be observed, from the cross-sectional view, that this form of centering obstructs in no way the passage of the men to and from the heading along the top of the pilot, on which a car track is laid.





Centering Plan for Hudson River Tunnel.

About 2½ ft. above the center of the sides, openings are left in the masonry to receive the ends of timbers *D*, whose opposite ends rest upon the pilot. These timbers are 6×6 in. and are spaced 3 ft. apart. Extending longitudinally, and resting on the timbers *D*, are the 6×6 timbers *C*, upon which the ribs *A*, are placed. These ribs are composed of two angle-irons, 2½×4×½ in. riveted together. On the ribs is a lazzing *B*, of 2×5-in. stuff, and on this the masonry is laid. At each end of the rib one of the webs of each angle is cut away and the other web is bent at an angle to form a bearing measuring 4×6 in. By wedging under the ends the height of the ribs can be adjusted according to the requirements. The timber *D*, also constitute a support carrying a platform for the masons. There is no waste in this plan as the same materials can be used over and over, and when not in use they take but little room and can be placed against the side of the completed work, out of the way.

The method of keying the arch is plainly illustrated in the longitudinal section. The courses are stepped back for a distance of about 2 ft. and this order is maintained to the end of the section where alternate courses project. This arrangement affords ample working space as the masonry is never less than 30-in. thick. In the inner course of bricks every other one project, while in all the other courses three or four bricks project, three or four are set back and so on.

As will be seen from our news notes the work is going on very smoothly and well, so far, and the material is proving exceptionally favorable for rapid work.

PUBLICATIONS RECEIVED.

The American Glossary of Architectural Terms, being a concise and comprehensive compilation of all terms used in the practice of Architecture and the Building Arts, A complete Dictionary of over 3,000 terms, historical, descriptive, theoretical, mechanical. Illustrated by many selected and original drawings. By GEO. O. GARNSEY, Architect; Editor of *National Builder*, author of "Trussed Roofs," "Estimating," "How to Build a House," Etc. Chicago, Ill., 1887.

As the author states in his preface, this work represents the labor of twenty years in collecting the data published. It is especially adapted to the wants of American architects and builders and, we believe, is the only work of its kind ever presented to them. It is handsomely illustrated and printed, and being in the form of a concise dictionary of terms should prove an exceedingly useful work of reference to all interested.

Buchanan's Tables of Squares, Containing the Square of every Foot, Inch and Sixteenth of an Inch between one-sixteenth of an Inch and Fifty Feet. For Engineers and Calculators. By E. E. BUCHANAN, Athens, Pa., 1887. E. & F. Spon, Publisher, 35 Murray St. New York. Price $3.00.

Institution of Civil Engineers—"The Treatment of Gun-Steel," by Col. EARDLEY MAITLAND R. A. This is a voluminous article with a long discussion already noted in this journal. "Printing Machinery," by ED A. CLOWES. The paper treats of printing machinery from the hand press of GUTTENBERG, to the latest improved power press.

Eighteenth Annual Report of the Massachusetts State Board of Health, 1887.

After an interval of nearly seven years this Board has been re-established with considerably enlarged powers and duties, and their first report contains much matter of great interest to the sanitary and municipal engineer. The report on "Rags and Infectious Diseases" seems to be an excellent one, showing that rags are dangerous, but not so much so as is often imagined. An excellent report on the water supply or sewage of ten towns shows a good beginning for investigations to cover the whole State, and the "Health of Towns" is admirably presented by diagrams or otherwise.

School of Mines Quarterly, Vol. VIII, No. 4, July 1887. —Contents:—Drift Mining, T. EGLESTON. Color Contrast, Prof. O. N. ROOD. Concentrated Boiling Load, R. W. HILDRETH. Geological Notes, Prof. J. S. NEWBERRY. Separation of Nickel and Cobalt from Iron, J.B. MACINTOSH. Concentration of Gold and Silver Ores on Pacific Coast, J. M. ADAMS. Scheme for Qualitative Analysis, A. J. MOSES. Comparative Delicacy of some Qualitative Tests, J. S. C. WELLS. Intercollegiate Boat Racing, Prof. W. P. TROWBRIDGE.

West of India Portuguese Guaranteed Ry.—At a recent meeting of the company in England, Gen TREVOR announced that the railway and harbor were practically completed. There have been considerable engineering difficulties. In the Braganza Ghat there is a grade of 1 in 40 for about 14 miles; the ghat line extends along a steep declivity of hills, drives through spurs by means of tunnels, and crosses huge chasms by means of viaducts and high embankments. One of these viaducts is 135 ft. high and there is an embankment of 125 ft.; there are various cuttings through granite 70 ft. in depth, and no less than 12 tunnels. The work, as already stated, is practically finished, and when the Southern Mahratta Railway also is completed the two companies will be enabled to join hands. There will then be a continuous railway system of upwards of 1,000 miles in length, leading from the port of Goa into the interior of British India. There is, however, some heavy work to be carried out by the Southern Mahratta Company before the final touch can be put to the connecting link.

ENGINEERING NEWS

VOL. XVIII. Saturday, July 23, 1887.

D. McN. STAUFFER. A. M. WELLINGTON.
EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

Subscription. — UNITED STATES AND CANADA, $5.00 *per Year*; $2.50 *for Six Months*; $1.50 *for Three Months*; *Single Copies*, 12 *cents*. FOREIGN COUNTRIES, $6.56 *per Year, or* 3 *cents per number additional.*

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THE address of Mr. A. ALLAIN, a draftsman, supposed to be residing in Newark and engaged in New York, is wanted at this office.

WHOEVER has occasion to take a West Shore train about now may notice, on some of the trains at least, a very curious contrast. The ordinary day coaches and even baggage cars will be seen to have very perfect trucks, with paper steel-tired wheels and abundance of of large and easy springs, both equalizing and bolster. These cars are remnants of the old stock, provided before the road fell into the hands of the New York Central interest, and the very best of their kind. The common run of passengers can ride in these cars without extra payment.

At the rear of the train they will (or ought to) note a "Wagner Parlor Car" for the luxuriously inclined—for a further consideration. These cars are not of the old stock, but are a benefaction from the Wagner company. The trucks are inferior in every way. They have only cast wheels, quadruple instead of septuple springs,and much stiffer bolster springs, the total weight of steel in the springs, at a guess, being something less than half that in the common old West Shore cars.

The natural consequence is that the latter should be very much easier riding than the "Parlor Cars," and having carefully observed both we can testify that this is in fact the case. Of course this is all legal enough. If people do not like the riding of the parlor cars they can save their money and ride in the day coaches. But there can be no doubt that it is a breach of the implied contract with the public under which parlor cars are run, and under which those profitable monopolies are alone defensible; that those willing to pay the best in the way of spacious and easy riding cars shall have it. And in view of the open secret that the Wagner palace cars are practically the property of a single family it excites a certain feeling of disgust to see them willing to swell an already overgrown fortune by what is in effect, to speak plainly, a fraud upon the public; charging for the best and not giving it. We do not complain of this policy because it is illiberal. Liberality, or illiberality, is a matter of taste. It is always a gracious and becoming thing for those who can afford it to be liberal, but no man has a right to demand of another that he shall be liberal, or that he shall forego any part of his honest profits because he already has enough and to spare. But to compel a man to pay for 100 shares of stock and only deliver half of it is something worse than illiberality, even when done under the forms of law. When a poor man does it we think he is none too honest. When a rich man does it our emotions are somewhat stronger. When the richest family in the world allows it to be done in their behalf—we write an editorial paragraph on the subject.

AMONG the more important action had at the late Kaaterskill convention must certainly be classed the resolution offered Mr. OBERLIN SMITH at the suggestion of Prof. THURSTON, and passed, requesting the Board of Direction to report on the advisibility of creating a standing committee on Technical Education, whose duties should be to keep an eye out on what was done in the colleges, and especially the colleges which have secured large funds from land-grants to be devoted to technical education, and to report to the society annually on the status and prospects of such education, thus affording a channel by which the views of practical engineers might find expression in such matters by advice, comment or recommendation of an unofficial kind.

The difficulty which at once suggests itself as to such a proposition is that for such a committee to do good work a great deal of time and study must be devoted to it, and that if this were not done the result might be worse than nothing. It is a very different matter from appointing a committee for specific work. Even in such cases the rule is that a majority of the committee do little or nothing but to read and sign the report, but in this case the work would be continuous,and it would be essential that all the committee should take part in it if their reports were to command or deserve respect, or be worthy of the society. Nevertheless, the society has a good many men in it, such as Mr. ECKLEY B. COXE, for example, who are at once men of comparative leisure, interested in the subject of education, and qualified by experience and education to comprehend such questions and perhaps give valuable advice in regard to them. With the proviso that a committee were selected which would be sure to say nothing unless it were sure that it had something to say, we cannot see why such a committee might not be so managed as to bring out useful facts in a useful way, although it is rather delicate ground to venture on.

WE have received from a "Division Engineer" a letter in reference to the American Society of Civil Engineers which is so wrong-headed and absurd that we decline to give space to it. He does not like the Society, and his principal reason for it, so far as we can make out, is that "its members apparently seek to degrade the young men of the profession"! A particular instance mentioned of this atrocious purpose is that one of its members offered "a graduate of an engineering school with over a year's experience" a position of "considerable responsibility" at a salary of $50 per month *without board*, while common labor was demanding $1.75 per day. The member who did this shameful thing was Mr. CHESTER B. DAVIS. His name was not sent in for publication, but no consideration for him shall keep us from holding him up to such public indignation as he deserves. In view of the salaries young doctors and lawyers and ministers "with over a year's experience" are known to command, this is none too severe a penalty for one who would insult a civil engineer of a whole year's standing with an offer of $2 per day, even had common labor been down to $1.50. And it is but a slight mitigation of Mr. DAVIS' offense that—if we correctly understand the case—he left the engineer free to accept the offer or not, as he chose.

We also have the more general charge that "excepting the Union Pacific, and Atchison, Topeka & Santa Fé, those railroads whose chief engineer officers are members of the Society, are the very ones where the most beggarly wages are paid and the working engineer most degraded," and an appended note states that "the roads most bitterly complained of are the Wisconsin Central, Chicago, Burlington & Quincy, and Northern Pacific." In the hope that it may lead them to mend their ways, we mention them specifically.

The moral to be drawn from such silly talk by a young man who, we have reason to believe, has shown considerable capacity for his profession, will be differently drawn by different men. To us, it seems to show that it is better to catch the cubs while they are young, give them a *quasi* connection with the Society for a certain number of years on easy terms, enable them to gain thus some glimmering idea of what such a Society is and what it exists for, and then let them drop out or stay in as may happen, after the probationary period is up.

MR. GOLDWIN SMITH speaks out very plainly in a letter to the London *Standard*, as also in a recent magazine article, in reference to the railway policy of Canada, as follows:—

"The four blocks of territory of which the Dominion is made up—that is to say, the maritime provinces, old Canada, the Northwest, and British Columbia—are connected by no natural bond of union, geographical or commercial. The maritime provinces are separated from old Canada by an irreclaimable wilderness: old Canada from the Northwest by another irreclaimable wilderness, and by the fresh-water sea called Lake Superior: the Northwest from British Columbia by a triple range of mountains. Each block, on the other hand, is closely connected, economically as well as geographically, with the portion of the United States immediately to the south of it—the maritime provinces with the New England States: old Canada with Maine, Vermont, New York, Pennsylvania and Ohio, the two last named states being the source of our coal supply: the Northwest with Minnesota, Dakota, and Montana, from which it is divided only by an imaginary line, and British Columbia with the Pacific States. Of the four divisions of Canada no two would naturally trade with each other, while each would naturally trade with the adjacent part of the United States.

"Up to this time, however, statesmanship has been struggling to unite what nature has divided, and to divide what she has united. The two instruments of this policy have been the political railroad and the Custom House. In the Intercolonial Railway Canada has been made to sink $40,000,000, and in the Pacific Railway she has been made to sink $100,000,000, not a cent of which in either case will she ever see again in any shape.

"Nature and man are now in revolt against this system, which will soon have no supporter outside a circle of politicians except the protected manufacturers; and not all of these. The revolt will spread. Commercial union, as I have said, is rapidly becoming the question of the day, while Manitoba is in arms against the exclusive privileges of the Canadian Pacific Railway,and bent on opening her communications with the United States instead of being condemned, as the separatist policy condemns her, to have no outlet for her produce but Montreal, which is 1,800 miles off and is not a winter port."

Many signs seem to indicate that "commercial union" has an immense following in Canada, as it is natural it should. Take the one specific case of Manitoba: It would undoubtedly give an immense stimulus to the development of Manitoba if it were in "commercial union" with the United States; in other words, if it were in all material respects a part of this Union; but who is hurt by the fact that it is not? Only the people of Manitoba; for there is still plenty of undeveloped territory within our own borders to afford room for enterprise, and the only practical difference to the people of the United States is, that their enterprises are diverted from Manitoba, and confined to our own country.

They are not thereby destroyed, even if a shade less profitable; and financial profit is not the only thing to be considered. Supposing the State of Rhode Island, which held out the longest of any against the Constitution under which we now live and prosper, had finally concluded that it would maintain its sovereignty politically, but would kindly assent to a "commercial union;" would it not have been laughed at? No doubt a very good financial argument might have been made as to each side being equally benefited, as there can in the case of Canada, but the good sense of the people would have seen the underlying folly of the proposition, and they can be relied on to do so in the case of this latest one, the sentiment in favor of which is entirely confined to Canada. So far as we can observe there is complete willingness in this country to let Canada work out its own future in its own way, uninfluenced even by advice. But to be commercially one thing and politically another is a trick or political legerdemain which has never yet been successfully performed, and which cannot with dignity be either attempted or countenanced.

WE find a curious paragraph in the Newark papers in respect to "a committee of the American society of Civil Engineers" having reported the new Newark sewers "in perfect order" and surmising that it is more than probable that the general public will accept *the decision reached* by the committee. No committee, as such, is ever authorized to "decide" in this way as to any public work, and this particular committee were simply volunteers who had gone out to see what there was to be seen for their own information. The tone of the press comments would seem to imply that some one was trying to grind an axe on a very soft grind-stone.

Panama and Nicaragua.

The latest Panama Canal loan is issued at a discount of 57½ per cent. Or, in other words, by lending $85 now the French investor gets "a promise to pay" $200 within 48 years and another promise of interest on this at the rate of about 7 per cent. Another provision in the published agreement authorizes a drawing every two months in the 48 years to determine certain bonds that are to be redeemed at once, making it possible for a lucky investor to draw his $200 within a few months. This is very desperate financiering, for the company not only agrees to pay $100,000,000 for $42,500,000 cash, but proposes at once to commence the process of reimbursement, thus reducing the amount available for the work in hand. Under existing conditions the end must soon come, for no commercial enterprise can long stand such a fearful strain. It is yet possible, however, for the "glory" of the French nation and the protection of over 350,000 French men and women, mostly of a class who could ill afford the loss of their investments, that the French Government will take up the canal work as a national affair. France is the only nation financially interested in it; all others have stood aloof, and put no money into the scheme. The temper of the French people is such that the Government may be forced into this now desperate enterprise, and by some judicious trimming of the overwhelming interest account, the introduction of a stricter system and discipline and suppression of extravagant measures, it may yet complete a canal of some kind at Panama.

In the meantime, with Capt. EADS dead, and the Panama Canal very likely to end in a compromise plan if completed at all, the Nicaragua Canal enterprise is stirring with a renewed vigor, and its promoters are reported to be even now in the midst of promising negotiations that when completed will enable them at once to proceed with actual work. The late payments of hard cash, to the amount of $100,000, to confirm the Nicaraguan concession, at least shows a very decided faith in substantial progress. This American canal project still lacks one essential feature, however, before the general American public can be held to look with full favor upon the enterprise. And this essential is a careful and complete survey by thoroughly competent and unprejudiced civil engineers. We are very glad to hear that the new management are earnestly discussing the best ways and means of supplying this want. We do not believe that we are "telling tales out of school" when we say that it is now in contemplation to have the President, or a committee, of the American Society of Civil Engineers, nominate a board of consulting engineers from among the best engineering talent this country can afford, and to have thorough surveys carried on under the direction of this board.

This seems a feasible and sensible way of getting at the solution of a very important problem. And this board, if appointed, will, no doubt, consider not only the engineering difficulties to be overcome, but also the quite as important element of financial and commercial success. The first consideration, and the point on which all else revolves, is the question—What will a thoroughly efficient and permanent canal cost? And then, upon a conservative estimate,—What revenue will it yield in the immediate future? The latter can be an estimate only, based upon a broad but careful summation of conditions. But before even a fair approximation can be made of the first we must *know* the ground and immediate surroundings, and we can only know this through the eyes of thoroughly competent and experienced men, and by the judicious outlay of large sums of money. The rock upon which the Panama enterprise has been so badly wrecked was the hasty jumping at work before the ground had been more than scanned over, and before any systematic plans had been formulated. Money, time and life were wasted thereby, and a burden of debt assumed that is now crushing the life out of the scheme. It is in the most friendly spirit, therefore, that we advise the management of the Nicaragua canal to *complete* their surveys and be assured that their estimates of cost are reasonably accurate and full *before* they commence to dig. Let them profit by the loose methods and sad experience of their French neighbor. We are told that the ground has all been gone over by the U. S. Government engineers; but with all due respect to the Navy, its officers are *not* civil engineers who have learned by study, long experience and hard knocks that species of knowledge which alone enables one to properly pass judgment upon the engineering features of such a canal and fix its probable cost. As illustrating the difference between an engineer "by brevet" and an engineer proper, we may mention that in the reconnoissance of the Atrato route for a ship-canal, Commodore SELFRIDGE—we believe it was—with a large staff of naval assistants, and all the material that the government could furnish simply verified the survey made by the late JOHN C. TRAUTWINE with the assistance of one Irishmen, some native boatmen, and good use of a pocket sextant and hand-level. But, in this case, Mr. TRAUTWINE was an experienced civil engineer, trained to his work and fitted by practice to make sound deductions from even a hasty survey of the field. The naval engineers, on the other hand, were applying a somewhat theoretical, school-boy knowledge, unbalanced by that experience which can only be gained by works. The one party was employed in the legitimate line of his profession: the other had stepped aside from its profession and was playing engineer as a bit of relaxation. It is hardly necessary to discuss the question of faith in conclusions and estimates emanating from parties so circumstanced. The general public are not engineers, but the possible investor knows enough about engineering to demand that any enterprise of this character in which he is to be interested financially, shall first be carefully studied and reported upon by men who have made engineering a profession. Hence, we again express our pleasure at the prospect of cutting loose this Nicaraguan scheme from its past purely naval moorings, and putting at its executive helm men who are better able to guide it to success. And, in saying this, we mean no reflection upon the Navy, for, in its legitimate field, we know no better workmen, but the status of the enterprise is now such that closer scrutiny and the most careful estimates are absolutely vital for its success, and these can only be secured from trained and able civil engineers.

An Unsafe Floor-Beam.

The continued personal tone of the discussion under the above head which has appeared in our issue of June 25 and again in our issue of July 9, and in this issue is something which we regret and must hereafter decline to permit. Whether Mr. BUDDINGTON did or did not approve of the bridge verbally or otherwise, at the time of its erection, and whether his motives are or are not purely scientific is quite apart from the question which, so far as this journal is concerned, is the sole one at issue, whether the floor-beams are now safe. But in regard to this question there are circumstances unknown to Mr. BUDDINGTON, and which were given to us directly from an officer of the New York, New Haven & Hartford Railroad, in justification of the floor-beam and in refutation of the charges against it, on which it seems to us proper to comment outspokenly "in the interests of good engineering" and of public safety.

It appears that when the question of the safety of these floor-beams was raised, the officers of the road, instead of going to some disinterested bridge expert to have the matter reported on, determined to investigate it for themselves. They had an alleged full-sized duplicate of the floor-beam made (which we may be reasonably sure was not inferior to the original) and then proceeded to test the beam *with jacks*, obtaining the total load by multiplying the gauge-pressure per square inch by the area of plunger. The proof stresses thus obtained, as given to us, did not amount by any means to "a proof stress of seven times the calculated safe load" which Mr. JONES comments on in our issue of July 9 as "rather unusual," and as making it "self-evident that Mr. BUDDINGTON'S assumptions as to the disposition of the strains in this girder are fallacious;" but we do not care to go into the exact figures of these tests, for a sufficient comment upon them is that whether they showed what they are claimed to have shown or not the whole method of making them was delusive and improper, *first*, in applying the load by common jacks, so that no one can tell within a large percentage what the actual stresses are, and *secondly*, in the assumption that because a new duplicate beam bore a quickly applied static load of 270,000 lbs. before permanent set, therefore the beams which were actually in use on the bridge were good to carry year in and year

out a live locomotive load of 77,600 lbs. + dead weight + impact, aggregating, according to Mr. BUDDINGTON'S original figures, which seem reasonable enough, 111,400 lbs. There are established methods of rigorous analysis for the strains in such a structure, which should first be appealed to. If they showed the structure safe, further tests by model might well be made if there still seemed room for doubt. If they showed the structure unsafe, no tests by model or duplicate are sufficient to prove the contrary, which do not go to the length of showing that the established theory of strains in beams is erroneous and needs revision, and no one nor two nor a dozen tests would be sufficient to do that.

Yet here we have the amazing spectacle of the officials of one of our richest corporations, and one of our greatest passenger roads, ignoring entirely the fact that there are these established canons of good practice for insuring the *continued* durability of iron work, and of riveted work especially, which are based upon the necessary assumption that, although a higher strength may be shown for the moment, from friction of plates, etc., while all is new and in good order, yet that only this and that can be counted in, and getting up a scratch test of their own at an expense (we were told) of $2,000 which after it is made proved and could prove absolutely nothing except that those who made it were not fit to do so. The teachings of experience seem to be wholly lost upon a large class of people They forget that the Ashtabula bridge was tested, and the Bussey bridge was tested, and almost every other structure which ever failed was tested to a load far beyond that which ultimately caused its collapse, and if a bridge shows little deflection, or if a beam will stand two or three times its intended load in a single quick test, they are at once convinced that it is "all right" for the service intended; and in some cases at least, as this example shows, are so strongly convinced as to confidently present the facts of their tests to an engineering journal as the sufficient answer to all criticisms. The structures of a road administered in this way may be every one of them all right, and in this case we earnestly hope they are and do not assert the contrary, but it goes without saying, to engineers, that their care is not in proper hands, and hence that there can be no assurance that a single one of them is all right, or that if they are to-day, they will be to-morrow.

Had we considered only our own feelings and preferences, or had we felt at liberty to consider only the officers of the road in question, we should have spoken of this matter in a much gentler way, but serious questions of public policy and public safety are involved in this kind of tampering with engineering problems by men in authority, who know nothing about them. Too many public and private officials act as if they had been placed in authority, not only over the persons and property under them, but over the laws of nature and of physics as well, and were *ex officio* qualified to interpret and control them. It therefore seems an appropriate occasion for a little plain speaking, especially as this is only a somewhat aggravated example of universal tendencies.

Our Map Series.

The many recognitions which we have received from subscribers and others of the value of the latest feature of our construction news, our recently initiated map series, have been very gratifying and have confirmed us in our belief that the technical public demanded and would appreciate a more systematic collection and intelligible presentation of such news than has heretofore been attempted. The country has grown so great, and its industries so active, that it is practically impossible to form an intelligible idea of what is being done and where it is doing by merely reading the newspapers, and still less by reading the disjointed clippings from the newspapers which do duty so extensively as "railroad news." Yet there are thousands of men in all parts of the country to whom it is a matter of serious moment to keep as well informed as possible on these matters, while every one wishes to do so, so far as may be.

To meet this need, we have arranged to publish at frequent intervals maps showing exactly what has been done and is doing, similar in their general style of execution to that which appeared in our issue of July 2 and 9, but for the most part to three times as large a scale, so that only one-ninth of the area of the United States will appear on a single map. These large scale maps will also give much fuller information as to roads under construction, or likely soon to be, than is possible on a small scale map of the whole United States, on which latter it is not feasible to show clearly anything more than the track laid, and we trust it is needless to say that, although it appeared well to issue an 1886 map even if somewhat late, they will appear hereafter promptly on time, since they are kept continuously on stone in process of correction. How often we shall publish maps of each section of the United States cannot be stated in advance, as it will depend on activity of work, but it will be at least once a year, and often two or three times a year.

As a necessary preliminary to the preparation of such maps we now keep, and have for some time, a complete running record of the status of every railroad and other large engineering project in the United States, the information for which is to a very large extent obtained by special correspondence. By turning to this record we are enabled to determine at once for any State or section in the United States, just what is doing and most likely to be done, which is of value not only for preparing our record maps but for ensuring correctness and completeness in our construction news.

The value of such a series, of course, depends almost wholly on its correctness and completeness, and hence we trust our friends everywhere who appreciate the value of such a record will do what they can to assist us in it by promptly sending us all news of interest, even without request, and especially by responding promptly to requests for information by circular or otherwise, as we are glad to acknowledge has been almost invariably the case so far. We must ask also that our friends who favor us with information will pardon us for not personally acknowledging their communications, since it would be practically impossible to do so. We aim to make our records of railroad construction and projects, not only more correct than any existing, for that they have long been and it is an easy matter to maintain, but as nearly correct as they can possibly be made. Hence, those who are cooperating with us by sending data of such work as comes under their notice will please accept this note as certifying our hearty appreciation of their kindness; and those whose usual practice it is to keep their work or schemes a profound secret are hereby cordially invited to confide in us at all times under the seal of the confessional.

We will only add further that any of our subscribers whose conscience impels them thereunto, and who desire to aid us in fulfilling the programme which we keep constantly before our eyes, to build up the greatest engineering journal of the world, as the character of our field demands, can easily cancel all obligations, if they choose, by extending the knowledge of what we are doing, which, they will probably find, is all they need to do to at once increase our subscription list.

Annual Convention of the American Society of Civil Engineers.

[Concluded from last week].

The technical proceedings of the afternoon of the last day were rather dull on account of the excessive heat.

In the afternoon a paper was read by Mr. C. H. SCHNEIDER, of Germany, on a method of destroying disease germs in sewage by the use of hot water. The cost was placed at two marks per cubic meter of sewage. CHAS. H. HASWELL read a paper on the "Operation and Results of a Single Expansion Steam Engine, Supplemented by the Evaporation and expansion of the Bi-Sulphide of Carbon and its Vapors," showing a great gain over steam, viz., a consumption of only 1.385 lbs. per H. P. per hour, for a very small engine. Following this paper came one by Mr. S. T. WAGNER, Supt. of Shops, Phœnix Bridge Co., on "Inspection of Bridges" in which he visited a rather sweeping condemnation on inspectors, and on steel tapes as well. This brought up a discussion on the use of steel tapes and steel rods for bridge measurement. Prof. JOHNSON described a steel tape, 300 ft. long, owned by the Washington University, which was used in four measurements of a base line and showed an error of only one in 1,000,000; the difference in two measurements showed an error of only one in 3,000,000.

Papers on the "Strength of Bessemer Steel Compression Members," by J. G. DAGRON, Inspector of Bridges on the Baltimore & Ohio R. R., and on the "Compression Strength of Iron and Steel," by C. H. MARSHALL, were read by title only. They were very full and valuable papers, not suited for reading aloud.

Mr. W. G. HAMILTON then made the following announcement.

"Mr. President: At a meeting of the sister engineers of the society, some solicitude (perhaps jealousy) was expressed at the white-hairedness, or bald-headedness, of the President and past President from too much brain power, and feeling perhaps it might extend to the members generally, (the committee, of course, being excepted) I am asked to read the following communication:

"The engineers who have been cultivating their heads during the day are invited to meet in the ball room immediately after the evening adjournment for the purpose of cultivating their heels, to thus maintain a balance of intellect. The ladies (who need no cultivating) are expected to be present to act as guard-rails to keep the members on the track. By order of the switch tenders."

MONDAY, JULY, 4.

A single session on this day opened with a paper by Mr. G. H. THOMPSON, of the New York Central, on the old locomotive Dewitt Clinton, which hauled the first passenger train in America, from Albany to Schenectady over the then Mohawk & Hudson Railroad. He showed by old drawings that the current pictures of that event were not correct, and by records that the engineer was not JOHN HAMPSON, an Englishman, but DAVID MATTHEWS, an American, who is still living, and contributed an interesting letter. Mr. COLLINGWOOD then submitted a progress report of the Committee on Compressive Strength of Cement. A recent report by the Chief of Ordnance on Tests of Metals and Other Materials, contained some valuable records of tests on brick piers and concretes. Cushioning the piers with wood, steel and plaster of Paris showed that wood cushions gave 25 per cent. less strength than steel. It was an invariable law that cement mortars mixed in air contract, and in water expand. In the first case it was progressive for 12 weeks; the expansion was less marked. The change was greatest in neat cement. Mr. W. C. WETHERILL then narrated experience with freezing mortars. They would set after thawing out, but it was not safe to rely on it. Mr. WHITTEMORE related similar experience with an important masonry pier. He also stated that it was an approximate law that mixtures always increased the strength of cement. Out of a quarry containing a dozen strata, cement made from mixtures of the layers invariably showed greater strength than from any one of the single layers. Neat tests were no criterion. Some cements which tested high neat would fall almost to zero with a slight admixture of sand. Mr. COLLINGWOOD mentioned that Portland cement will not bear admixture of lime. Mr. WORTHEN instanced New York experience that laying masonry in winter was safe enough within wide limits. Mr. BOGART mentioned tests of a New York State cement which showed greater strength 1 to 1 than

neat. This Mr. WHITTEMORE explained as due to the great activity of neat cement. Incipient setting began before the briquettes were molded. He did not favor neat cement tests. Messrs. NOYES, MCALPINE, PRINDLE, FLAGG, NORTH, KUICHLING, Gen. GREENE and others continued the discussion, which proved a very interesting one, although much of it was merely going over old ground. Mr. WHITTEMORE mentioned an instance, which caused much laughter, of a cement man who was paid 50 per cent. extra to guarantee always good cement. His simple recipe was to empty 10 bbls. together on the floor, mix thoroughly with a shovel, and re-barrel.

Mr. JOHN F. O'ROURKE occupied the remainder of the morning session with his valuable paper on the foundation work of the Poughkeepsie bridge, which was visited by a large proportion of the members next day. As we have already given much in reference to this work, and shall hereafter give more, constituting a complete record, we will not now attempt a summary of the paper, which was carefully prepared and complete, and accompanied by many drawings.

WEDNESDAY, JULY 6.

Mr. ROBT. MCMATH, of St. Louis, was elected Chairman, Mr. T. C. CLARKE being absent. A paper on "Disposal of Sewage in Massachusetts" was read by Mr. FRED. P. STEARNS. He pointed out that Massachusetts was now more densely populated than France and Germany and nearly up to the maximum of Europe. A Drainage Commission was appointed in 1884 to report on the relief of the Mystic, Blackburn and Charles Rivers and their water shed, of which Mr. E. C. CLARKE was Chief Engineer, reporting to Mr. J. P. DAVIS and RUDOLPH HERING, Consulting Engineers. The present staff consisted of the writer as Chief and J. P. DAVIS as Consulting Engineer. Full details of their work were given, which we cannot now attempt to do justice to. A valuable discussion by Mr. CHAS. ALLEN, giving the results of his European investigations and full of technical details, was then read. Mr. E. C. CLARKE followed with a description of some small sewage works at Medfield, Mass., covering only one acre of ground, divided into four parts which were used alternately. A somewhat amusing discussion as to whether there was or was not objectionable odor from English and other sewage farms then followed. Mr. CLARKE took one side and Mr. KUICHLING, of Rochester, the other. The burden of evidence appeared to be that they are in no sense nuisances. The sewage question at Rochester, N. Y., and Chicago, Ill., was also informally discussed and many interesting details given which have, however, already appeared in these columns for the most part. As a whole, it was a very interesting and instructive discussion for sewage engineers.

Mr. WM. H. WILEY then described the East Orange Sewage Works, which have some very interesting features, and extended a general invitation, which quite a number accepted, to visit the works after the Convention.

Prof. R. H. THURSTON made an address of some length, which was listened to with general interest, on the subject of technical education, and especially on the use which was being made of the land grant funds derived from the general Government, which he feared were in some cases being devoted merely to general education and not specifically to technical education. Even when they were used for the latter nominally there was a great difference in the practices of the various colleges, some of which were wisely conducted and some not. This address was followed by the resolutions on the subject at the succeeding business meeting, which we reported last week.

The afternoon session began with a long and fully illustrated paper, describing in great detail the mechanism of the Brooklyn Bridge Cable Railway, by Mr. G. LEVERICH. The most striking single fact brought out was the efficiency of the Paine grip in reducing wear of cable, which was chiefly at the terminal shears. Large detail plans of the sewage works at Newark, N. J., were then exhibited and described, which we have already described in part.

Prof. THURSTON then exhibited, as quite new, samples of blue-prints made by the new process of dispensing with glass by wrapping first the sensitive paper and then the tracing to be copied around a large wooden cylinder. It gives most excellent results, better than with glass, especially with mechanical arrangements to slowly turn the cylinder. Some amusement was created by the announcement of a member that he had seen the same process described in ENGINEERING NEWS some weeks before, and had immediately ordered one of the cylinders made.

THURSDAY, JULY 7.

The attendance at the meetings on this last day of the Convention was very slim. Most of the members thought they would benefit more by carriage drives or walks, and no doubt with truth, since the meetings were pretty steadily held, and a great deal of work ground off. A controversial letter from an officer of the Panama Canal Co, was first read, claiming that recent reports were unfounded. As we are somewhat weary of this question, and think everyone else is, we pass it entirely. There was nothing brought out which seemed to us to controvert the essential correctness of what we have published.

A discussion of Prof. ROBINSON'S paper on "Bridge Vibrations," by THOS. H. JOHNSON, of the P. C. & St. L. Ry., then followed. He admitted the vibrations, but controverted Prof. ROBINSON'S explanation of causes, in which we think he was right. A paper on "Stresses in Bridges," by Mr. W. H. BOOTH, of Manchester, England, then followed. It was a carefully prepared paper but brought out nothing especially new. A paper by Mr. MACE MOULTON on the Kentucky & Indiana Bridge, was then read, of which we shall give a fuller account later. Two discussions were then presented on Mr. WELLINGTON'S paper on "The American Line from Vera Cruz to the City of Mexico," by Messrs. O. L. NICHOLS and A. BRYSON. Mr. WELLINGTON was not present to answer the discussions, which were on minor points.

The closing session opened at "15.30 o,clock" with still fewer members present. Three discussions of the questions on bridge inspections, etc., which had been sent out were the first ones presented, by Messrs. J. M. WILSON, S. H. PEGRAM and J. A. L. WADELL, Mr. WILSON thought that roads should be divided into three classes. He preferred outside guard-rails, and entered at length and very carefully into what was good practice as respects inspections. Mr. PEGRAM did not like buckle plates but did like the Latimer guard. Legislation he feared would be ineffectual because of the difficulty of getting proper men to execute the laws. Prof. WADDELL thought legislation on a careful plan which he sketched might be effectual. A number of other discussions, bringing out no especially new points, were presented and the Convention adjourned *sine die*.

FRIDAY, JULY 8.

The members started for home stopping at the Cement Works of Mr. F. O. NORTON on the way. Mr. NORTON being absent in Europe, his manager, Mr. C. M. HARRIS, took charge of the party, and after it had critically inspected an admirable lunch provided by Mr. NORTON, it was taken through the mines and works, which are among the best and most extensive of their kind in America. The works have been so fully described and illustrated in these columns that we need not repeat the details, and after about three hours spent at the works the party took a West Shore train and started for New York, arriving in the evening.

Thus ended one of the most successful, if not the most successful conventions on the annals of the Society. The attendance was not quite as large as has been stated, 160 members and 99 ladies and other guests having been in attendance, but it was thoroughly enjoyable and enjoyed, and the policy of holding conventions at some one large hotel without the distraction of excursions may now be considered so well established that there is little likelihood to be of variation from it hereafter, unless for some special occasion. Among the places most strongly talked of for next year's convention is the Straits of Mackinaw, where a large hotel has recently been erected. The probabilities are more in favor of this location than of any other one place. The Hotel Kaaterskill proved in every way a desirable and pleasant place for such a meeting.

A PERMANENT way engineer writes to *The Engineer* in respect to joints and hot weather:

"I have had a very lively time of it with this wave of heat. We have blindly introduced steel fish-bolts, bolts that require a wrench 5 ft long. The consequence is, the bolts have been screwed up too tight, and in spite of warnings of previous years, I had a case of the steel rails buckling, diverging 9 in. from the straight line, and, of course inclined to go further. Luckily the train was going slowly. Gangers had been ordered to slacken the bolts, but neglected to do so. I had sent out orders to slacken these steel bolts. On a neighboring line there were 300 yards of the line impassable by buckling, and near Liverpool the line was impassable from the same cause. There was room between the rail ends, but the bolts prevented the rails from sliding in the fish-plates. It is a bad reflection on engineering talent. Now I have the fish-bolts loosened, I am threatened with a creeping of the line, which will jam up the joints close at the bottom of the hill. Rails are not sufficiently anchored in their places; nothing holds the rails of many lines except the friction at the side of the rail between it and the dry, loosened wood keys.

CORRESPONDENCE.

The Cost of Wire Fences.

EDITOR ENGINEERING NEWS:

A correspondent recently asked about the cost of building wire fences. I had some experience a year ago, and then we paid ten cents per rod for the work. Posts were set 16 ft. apart with two stays between. Five wires were used, and all material was furnished at the nearest station on side track except the posts, which were thrown off every mile alongside track. This price included all gates, which were common board "lift and swing around gate." The soil was largely a Nebraska "Gumbo," very hard to bore in. On better soil we got the same work done for nine cents per rod. Even an approximate cost is hard to give as total cost of posts, braces, lumber, wire and staples all vary. On many of the Wyoming ranches, where freight from the nearest railroad point cost $3 per hundred on wire, It took money to build fence.

A. M. VAN AUKEN.

An Unsafe Floor Beam.

NEW HAVEN, Conn., July 12, 1887.

EDITOR ENGINEERING NEWS:

I beg leave to say a few words in reply to the communication published in your issue of the 9th. inst. over the signature of J. R. JONES. I shall divide my remarks in the same order as followed in the aforesaid communication:

First. The type of engine shown in the diagram published in your issue of 25th ult., and which I understand Mr. JONES to object to as excessive, or more than the beam was designed to carry, was taken from the original strain and section sheet prepared by the contractors for the bridge in which the defective floor beams occur; the date of the said strain and section sheet is Nov. 1, 1883. Of the "mogul" engine I shall speak further along.

Second. It is practically of no appreciable consequence whether the dead load is taken at 14,400 lbs. or 11,800 lbs., so far as modifying sensibly the conclusion arrived at in regard to the beam. But inasmuch as the dead load in question is a computed or estimated one, and as a good part of it—4,900 lbs.—is made up of ties and guard timbers, the weight of which will vary according to the state of the weather, cock-sureness, in speaking of it as exactly thus or so, seems to me to be slightly out of reason.

Third. The information given in regard to the alleged test is too meagre to enable one to pass upon the worth of the test as bearing upon the safe capacity of the beams in the bridge. Granting that the test was made *bona fide* as stated, in order to interpret it intelligently it would be necessary to know just how the beam was supported, how the load was applied and whether the material of the girder was exactly the same as that of those in the bridge. Again, the beams in the actual structure are, in all probability, of simply average workmanship, whereas the greatest care and attention may have been exercised in the building and fitting of the one to be tested. Moreover, riveting that is just from the riveting machine would probably give, when tested, a much higher result than the same after it had been subjected to the repeated applications of even a moderate stress. We all have heard of tests that established the strangest and most incredible things. I hope Mr. JONES will be generous and make public the details of this remarkable experiment; it may revolutionize the present practice in designing.

Fourth. Mr. JONES asks if an end shear of 270,000 lbs. in the web of the beam would not give an average stress of 29,000 lbs. per rivet, and an average bearing stress of 89,000 (88,000) lbs. per sq. in. on the first ten rivets of the girder. I reply, certainly: The moment of this end shear or reaction, with reference to any point along the flanges between the end and the point of application of the first concentrated load, is obtained by multiplying this end reaction by the horizontal distance from the first named point to the center of the end support; and this moment must be equal to the moment of resistance of the flange rivets included between the aforesaid point and the end of the beam, i. e., the

total resistance of these rivets multiplied by the vertical distance between the mean pitch lines. (I leave out of consideration here the bending resistance of the web plate, and assume that all the flange stress is carried by the flanges—an ordinary requirement of every good specification that I know of; but whether the web resistance is taken into account or not affects the result only about 10 per cent). The stress on the first eighteen rivets, or all those from the end of the beam to the edge of the outer stringer, would be, under a load of 270,000 lbs. per each half of the beam, $270{,}000 \times 47\frac{5}{8} \div (35\frac{5}{8} \times 18 \times 21\text{-}64) = 61{,}000$ lbs. per sq. in. (For linear dimensions, refer to diagram.) This is according to the simple and elementary principles of mechanics, and gives rise to a not unnatural distrust as to the reliability of the results of the alleged empirical test.

Mr. JONES states that he "has neither the leisure nor the inclination to teach Mr. BUDDINGTON how to calculate the stresses in a girder with flanges not parallel." Why, the method of calculation followed does not assume that the flanges are parallel. The method is applicable to any girder, whether the flanges are parallel or not. Moreover, taken in connection with what he has previously said, his position in the statement quoted is simply ridiculous. He has just referred to an alleged experiment that would probably cost from $400 to $500, when he might have saved this expense—if he had only chosen to—by simply showing by calculation that this girder was correctly proportioned to sustain safety the load that it was intended to carry. Yet he would not save $500 by an hour's work, or less, with pencil and paper! I know that one official of the railway on which this bridge is located has been earnestly seeking for some time some competent person to show by calculation that this girder is all right. Now, Mr. JONES comes along and placidly says *he can*, but *he won't*.

Mr. JONES' conclusion bears to me internal evidence of being a joint production of himself and the vice president of the railway to whom he refers, and was probably concocted and agreed upon for the purpose of putting the best possible face on a somewhat ugly matter. It contains some truth, but is so mixed up with untruth that it is worse than an absolute lie, for it is harder to refute.

It is true that I was chief engineer of the railway on which the bridge that contains the defective floor beams is located, when the bridge was built. It is not true that I approved the detail plans and bridge itself, and pronounced it the best bridge in New England. If Mr. JONES, or anybody else has a detail drawing of this floor beam with my signature of approval, that signature is a forgery. As for saying that this bridge was the best one in New England, I strongly suspect that the statement made in the premises is the result of mistaken identity; somebody else said this, and Mr. JONES has "just mixed those persons up." I never said it, because, first, I knew better; second, I was a little piqued because I was not permitted to design the bridge myself, and, therefore, would not have been likely to praise it in this fashion, and third, it would have been passing an adverse criticism upon my own work, past and future, and whoever heard of anybody foolish enough to do this! No, the best bridge on the line of this railway, and one of the best bridges in New England, in my opinion, is one at Saugatuck, an economically built bridge it is too. It contains 835,303 lbs. of iron, cost $28,948; while Mr. JONES's bridge contains 2,742,765 lbs. of iron and cost, so I am told, $155,000. By "rule of three" the cost of the latter should be $28{,}948 \times 2{,}732{,}765 \div 835{,}303 = \$94{,}705$, a relative difference of more than $60,000. The difference ought to appear the other way, because the former bridge was of more expensive character. I am thankful for the opportunity given to point out this fact.

As to the assertion relative to approval of plans and strain sheets at the time of receiving proposals for the bridge: I would say that blue prints from two parties, showing simply strains and sections of the principal members of the proposed structure, were handed to me with instructions to go over the figures and see they were correct and sufficient. I was also instructed to state which of the two designs was the better one. No detail drawings accompanied these strain sheets, and no proposals. I was not asked to consider the element of cost or economy. In examining the section and strain sheets referred to I made use of a table of uniform live loads that were equivalent, with an allowance for impact to the actual loads that would be occasioned by a "Mogul" engine weighing 180,500 lbs. in a space of 57 ft. 5 in. instead of the "Consolidation" weighing 172,000 lbs. in a space of 55 ft., which was assumed as a basis in the strain sheets submitted. This table of uniform live loads showed the proper weight to be taken per foot up to 200 ft. For ten feet; it required 6600 lbs. per ft. or for 20 ft. 5500 lbs. For 18 ft. 9 in. it would require 5640 lbs. per ft. I found neither of the plans strictly up to what I considered requisite, though the one submitted by JONES & BENNER was nearly so and with slight corrections would be sufficient, and their design was in my opinion the simpler and better of the two. Now this was the substance of the verbal report that I made to the official of the railway who had given me instructions in the premises. I subsequently caused to be prepared a strain and section sheet showing what changes I had made; this strain sheet was forwarded to the contractors, I believe. Whether it was ever attached to the contract and specifications for this bridge and became a part thereof, I cannot say. I never have seen a copy of the contract and specifications. I urged upon the Vice President of the road who had charge, of the matter, the necessity of requiring the contractors to submit full detail drawings to be signed and approved before the work in the bridge shop was entered upon. No attention was paid to my suggestion. I was shorn of all authority in the premises, and reduced to a tool.

Now if there was a contract and if the strain sheet that I speak of was attached thereto, then the live load that the floor beam was required to sustain safely, in addition to the dead weight, without occasioning a stress of over 12,000 lbs. per sq. in. of rivet bearing and 4,000 lbs. web shear, was, as previously noted, $5{,}640 \times 18.75 = 105{,}750$ lbs. on each half of beam, and not 68,400 lbs. as Mr. JONES would have us believe.

I come now to the kernel of the matter. In the original strain and section diagram submitted by the contractors for this bridge, there was shown a small sketch of the floor-beam. the beam, as there shown, was 42-ins. in depth throughout, the web plate was ⅜-in. thickness except in the end bay, where it was shown $\frac{7}{16}$-in, in thickness. Now in the bridge the web of the beam is reduced to 28-ins. in depth and to ⅜-in. thickness at the end reduced, just where section was most needed, from 18½ sq. ins. to 10½ sq. ins. A queer sort of transaction this.

As to the assertion that I never found any fault with this bridge until two years after it was completed, I say that assertion is untrue. As a matter of fact I was "kicking like a bay steer" all the while from the outset. The railway official who had the building of this bridge in hand was informed by me on two separate occasions before the bridge was completed, that the floor-beams were not what I supposed they were required to be. He simply did not believe it. He did not even believe it, when, having heard that another bridge similar to the one under discussion was contracted for, I went to him and ascertained that the report was true, and tendered my resignation, saying that I would not be mixed up in another transaction of this sort—though I then supposed that he did believe it, for he said that the beams would this time be of uniform depth throughout.

I append a copy of a letter to Mr. THEODORE COOPER, and an answer thereto in relation to the defective floor beam shown in your issue of 25 ult. It was obtained to send to a certain individual for the purpose of corroborating what I had said to him in regard to the defects noted. I gave the dead load upon each half of beam as 12,600 lbs. in the sketch sent to Mr. COOPER; a later revision led me to believe that 14,400 was nearer the correct amount.

Yours truly, J. E. BUDDINGTON.

[This correspondence, if it goes any further in these columns, must be free from personalities and personal questions, and confined purely to technical matters. We have allowed Mr. BUDDINGTON his say freely, since we allowed the same to his opponents, but there can be no further excuse for personalities which do not at all affect the question in dispute. What we have to say further in respect to the matter is said on another page. The following is the correspondence enclosed and above referred to.—ED. ENG. NEWS.]

THEODORE COOPER, Esq., Cons. Eng., etc.,
35 Broadway, New York.

DEAR SIR:—Please examine the enclosed sketch of a floor beam of a railway bridge and state the maximum load that can be safely applied at each of the two points indicated in said sketch, without occasioning greater stress on rivets and in web plate of end bay than permissible, according to the usual specifications or unit stresses in such cases.

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Truly etc., J. E. BUDDINGTON,

New Haven, Conn., Oct. 6, 1886.

35 *Broadway*, NEW YORK, Oct. 7, 1886

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DEAR SIR:—Yours of 6th inst., inclosing tracing of a floor beam for a double track bridge, is received.

You desire me to state the maximum load that can be safely applied at the stringer connections without occasioning a greater stress than permissible, according to the usual specifications upon the rivets and web plate.

Now, while there is no universal agreement upon the above points, my own views upon these as expressed in my general specifications, and, as I believe, accepted by at least the majority of our best bridge experts, are as follows:

Allowed shear'g stress in web plates 4,000 lbs. per sq. in.
" " " " rivets 7,500 " "

Allowed bearing pressure on rivets and web plates 12,000 lbs. per sq. in. of projected intrados (diameter by thickness of piece). Taking up your submitted tracing from this point of view, I have to report as follows:

The maximum shear at the end bay will be $2w$.

(*a*) Shear on web at end.

$28 \text{ in.} \times \frac{3}{8} = 10.5 \times 4{,}000 \text{ lbs.} = 42{,}000 \text{ lbs.} = 2w.$

$w = 21{,}000$ lbs., deducting dead load, 6,300 lbs., we have allowed live load on each stringer 14,700 lbs.

(*b*) Pitch of rivets in flange angles at the end = 2½ in.

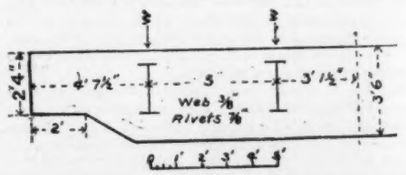
Allowed rivet strain for shear (double) = 9,000 lbs.

" bearing pressure on web = 4,000 lbs.

$$\frac{\text{Depth of girder} \times \text{allowed rivet strain}}{\text{pitch of rivets}} = 28 \div 2\tfrac{1}{2} \times 4{,}000$$

$= 44{,}800 \text{ lbs.} = 2w$

$w = 23{,}400$ lbs.; deducting dead load, we have allowed live load on each stringer = 16,100 lbs.



(*c*) The connection of a double track floor-beam rigidly to the posts in the manner shown, requires very complicated computations to determine the strains induced in the rivet connections and throughout the floor beams, especially when one track only is loaded. From the unequal deflection of the trusses under a one track load, the rigid connections at the end must produce excessive strains in the floor beams and posts.

It will be seen from (*a*) and (*b*), that this floor-beam is not properly proportioned, for it is only equal to a live load often induced by a single pair of driving wheels of a locomotive. Yours very truly,

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Computing the Deflection of Trusses.

CHAMPAIGN, ILLS., July 15, 1887.

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In connection with the discussion in late numbers of ENGINEERING NEWS of the deflection of a truss, it may be interesting to note that according to Prof. JOHNSON'S formula, the deflection due to the web of a 120-ft. single quadrangular truss of six bays, inclined end posts and tension diagonals at 45°, is 0.163 in. while ⅝ of the deflection due to the chords is 0.144 of an in., which is a substantial agreement with the rough estimate of page 393. For a 200 ft. truss the deflection by Prof. JOHNSON'S formula due to the web is 0.474 in., and ⅝ of that due to the chords is 0.395 in. Under like conditions, the total deflection by the approximate method is a trifle greater than that by the more rigorous one. In view of the great amount of extra work involved in the application of the more rigorous method, and also of the nature of the problem itself, it is very doubtful whether the increased accuracy is worth what it costs. Yours truly,

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General Formulae and Table of Coefficients for Calculating the Strains of the Belgian or American Roof-Truss.

PITTSBURG, Pa., June 13, 1887.

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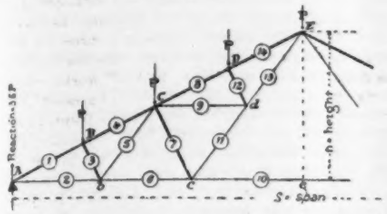
I enclose general formulæ and a table of coefficients for calculating the strains in a Belgian or American roof truss which I have recently developed, trusting that they may be of interest to some of your readers at least.



$n = \frac{S}{h} \cong \frac{1}{Pitch}$; P = load at points of support of rafters; $\begin{cases} + \text{ tension.} \\ - \text{ compression.} \end{cases}$

The load P is equal to the horizontal area of roof supported by one truss multiplied by the load per square foot, and the result to be divided by 8.

The weight of structure is usually included in the assumed unit per square foot.

To be Multiplied by P.

Member.	$n = 3$.	$n = 4$.	$n = 5$.	General Formula.
1	6.3097	7.8263	9.4241	$-\frac{1}{4}\sqrt{n^2+4} \times P$
2	5.25	7.0	8.75	$+\frac{7}{8} n \times P$
3	0.8321	0.8945	0.9285	$-\frac{n}{\sqrt{n^2+4}} \times P$
4	5.7551	7.3791	9.0527	$-\frac{1}{\sqrt{n^2+4}}(\frac{7}{4} n^2+5) \times P$
5	0.75	1.0	1.25	$+\frac{n}{4} \times P$
6	4.5	6.0	7.5	$+\frac{3}{4} n \times P$
7	1.6641	1.7889	1.857	$-\frac{2n}{\sqrt{n^2+4}} \times P$
8	5.2004	6.9319	8.6813	$-\frac{1}{\sqrt{n^2+4}}(\frac{7}{4} n^2+3) \times P$
9	0.75	1.0	1.25	$+\frac{n}{4} \times P$
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The general formulæ have been derived from repeated application of the well-known Ritter's method.

The coefficients for $\frac{1}{3}$, $\frac{1}{4}$ and $\frac{1}{5}$ pitch will answer for most practical purposes. I may say at this place that if local requirements in certain cases do not make it impossible, it seems to me very desirable to design every roof to a certain pitch, no matter what small or odd fraction of an inch may happen in the figure for the height of the same.

This affords simple means of determining lengths and levels of the members of the truss, and makes details similar and the work otherwise easier. I intend to add some tables for calculating the lengths of the members in a following contribution.

Yours truly, F. FELKEL.

[This method is not new, being already used in the offices of several engineers, to our knowledge, in lessening the labor of calculation. But as our correspondent remarks, it may be new to some of our readers, and for their benefit we publish it.—ED. ENG. NEWS.]

A New-England man has just had a patent granted to him for "an electric switch." The particulars are not given, but it looks as if the future of the small boy was discouraging.—*N. Y. Tribune.*

"Engineers."

63 *Calle Constitucion.*

CORDOLA, Argentine Republic, May 30, 1887.

EDITOR ENGINEERING NEWS:

Although the writer is aware that he is treading a well-worn path, he cannot refrain from again referring to an old question, one which, if he is not mistaken, has been touched upon by one of the present editors of the NEWS in a more or less extended article.

Is the English language, as spoken and written by the North American people, so poor that there can be found no word to distinguish between the man who controls a steam motor and the man who designed and constructed it? Can we not express, without explanatory foot notes, what we mean? May we not make a distinction between a man who is a master of the laws of applied sciences and a man who executes these laws, or manipulates a combination of applied forces to the end that those combined forces may be utilized?

In plain terms, may we not distinguish the *engineer* from the man who handles an engine? Parliament has recognized "Webster's American Dictionary of the English Language" as authority. Oxford and Cambridge have, as a consequence, declared it to be the standard upon which they base their understanding and teaching of the *idionia*, yet they, the Britons, do not confound the *engineer* with the *engine driver* either in print or in speech. It may be that this is more rigidly impressed upon a North American when abroad than when at home, for the reason that in none of the languages of modern Europe does he find this compound meaning, this conflict of ideas, this joint proprietorship of titles.

A foreigner, in reading a North American scientific journal, is constantly confounding the *engine man* with the *engineer*, and is in many instances in doubt as to which acceptation of the term to take, if, indeed, he knows there is but one. It may be repaired that the North American journals, either scientific or otherwise, are not written for foreigners. This, upon the "sufficient unto ourselves theory," —a very narrow one, by the way—yet are we quite sure that, in all cases, the term *engineer* is not just a little ambiguous to the general reading public within the limits of our own territory? And more, we should so express ourselves, in print at least, that we may be clearly understood abroad, for at the present, the Anglo-Saxon is regarded abroad as far in the advance in engineering matters. "A rose may smell as sweet by any other name," but it ceases to be a rose.

F. L. GRISWOLD.

[The confusion is unfortunate but it seems past curing. The *English* term "engine-driver" will never become naturalized in this country, and "engineman" although much used by "Engineers" is little used by any other class and is not likely to become general. A little niece of the editor of this journal, on learning that her prospective uncle was an engineer, expressed the hope that he might in time be promoted to conductor, and little ambiguities of that kind can hardly be avoided. The English have not precisely the same difficulty but they have a similar and greater one. The men whom we call machinists and the French, (as also the engine-driver) mécaniciens are known in England as Engineers. Every firm who do any kind of work in iron or steel are a firm of "Engineers" and every man in their employ is likewise an "Engineer" and belongs to the "Amalgamated Society of Engineers," if that is its precise title. After all, it is a small matter. "It pleases her and don't hurt me," said the man when his wife was beating him, and we may say the same.—ED. ENG. NEWS.]

Rail Exhibits at London and Paris.

WESTMINSTER, LONDON, July 8, 1887.

EDITOR ENGINEERING NEWS:

Being convinced that it is essential to the welfare of railway communication for safety, comfort and economy to introduce heavier rails and also that, because of the time it takes to break the ice and convert engineers out of their old grooves, no opportunity should be lost in laying before them facts—not in the form of papers, drawings or figures, but the actual thing—steel rails executed and laid upon tracks, I send you the following facts:

I have succeeded in converting the Belgium State Railway engineers to the use of a heavy Goliath rail, say about 100 lbs. per yd. They had it rolled at Seraing and laid upon the track between Brussels and Antwerp, with the good result that it is to be continued and adopted for all the main line system of railways in that country. It is, therefore, time to hope for sounder things, and consequently Messrs. COCKERILL have exhibited this heavy rail in Paris at the Centennial, and I in London at the American Exhibition.

I enclose a description of the former, the one in Paris—and have now to give you a short resumé of mine in London.

The object being the introduction of heavier flange-rails for all countries—I have taken a stand and invited all makers in America, England, Belgium, Germany and France to send short rail pieces of their heaviest sections for exhibition, free of all patents and of all charges—and I am happy to say the stand is well represented.

From America there are rails from Bethlehem Steel Works, and Joliet, neither, however, approaching in weight anything like the Goliath—There are English rails from Barrow and West Cumberland—90 lbs. to the yard; also rails weighing 80 lbs. from Rhymuey and Aberdale in Wales, and some lighter ones from Germany. Of course the 100 lbs. Goliath is the heaviest rail of the stand, but all countries are represented with a view to showing the different types of sections as well as the heaviest weight used in each, and so promote safety, economy and comfort, in fact, to let the permanent way grow in proportion to what the rolling stock has grown through the increased traffic, as there has come to be, rather a disproportion in many instances between the two divisions of railway plant.

Yours truly, C. P. SANDBERG.

The Goliath Rail.

19 *Great George Street, Westminster, S. W.*

LONDON, June 20, 1887.

EDITOR ENGINEERING NEWS:

Knowing the interest you have taken from the very birth of the Goliath rail, no one, I think, is more entitled to have the first news about its behavior in practice (that is to say, in making, laying and using,) than yourself.

You have already published the fact about the facility in rolling and finishing. I have now to inform you equally good news about its being laid on the track, and finally upon the smoothness in running on it. I have assisted at all these operations on the Belgian State lines, and can speak with impartiality, notwithstanding I call it my Goliath.

total resistance of these rivets multiplied by the vertical distance between the mean pitch lines. (I leave out of consideration here the bending resistance of the web plate, and assume that all the flange stress is carried by the flanges—an ordinary requirement of every good specification that I know of; but whether the web resistance is taken into account or not affects the result only about 10 per cent). The stress on the first eighteen rivets, or all those from the end of the beam to the edge of the outer stringer, would be, under a load of 270,000 lbs. per each half of the beam, $270{,}000 \times 47\frac{5}{8} \div (35\frac{3}{4} \times 18 \times 21\text{-}64) = 61{,}000$ lbs. per sq. in. (For linear dimensions, refer to diagram.) This is according to the simple and elementary principles of mechanics, and gives rise to a not unnatural distrust as to the reliability of the results of the alleged empirical test.

Mr. JONES states that he "has neither the leisure nor the inclination to teach Mr. BUDDINGTON how to calculate the stresses in a girder with flanges not parallel." Why, the method of calculation followed does not assume that the flanges are parallel. The method is applicable to any girder, whether the flanges are parallel or not. Moreover, taken in connection with what he has previously said, his position in the statement quoted is simply ridiculous. He has just referred to an alleged experiment that would probably cost from $400 to $500, when he might have saved this expense—if he had only chosen to—by simply showing by calculation that this girder was correctly proportioned to sustain safety the load that it was intended to carry. Yet he would not save $500 by an hour's work, or less, with pencil and paper! I know that one official of the railway on which this bridge is located has been earnestly seeking for some time some competent person to show by calculation that this girder is all right. Now, Mr. JONES comes along and placidly says *he can*, but *he won't*.

Mr. JONES' conclusion bears to me internal evidence of being a joint production of himself and the vice president of the railway to whom he refers, and was probably concocted and agreed upon for the purpose of putting the best possible face on a somewhat ugly matter. It contains some truth, but is so mixed up with untruth that it is worse than an absolute lie, for it is harder to refute.

It is true that I was chief engineer of the railway on which the bridge that contains the defective floor beams is located, when the bridge was built. It is not true that I approved the detail plans and bridge itself, and pronounced it the best bridge in New England. If Mr. JONES, or anybody else has a detail drawing of this floor beam with my signature of approval, that signature is a forgery. As for saying that this bridge was the best one in New England, I strongly suspect that the statement made in the premises is the result of mistaken identity; somebody else said this, and Mr. JONES has "just mixed those persons up." I never said it, because, first, I knew better; second, I was a little piqued because I was not permitted to design the bridge myself, and, therefore, would not have been likely to praise it in this fashion, and third, it would have been passing an adverse criticism upon my own work, past and future, and whoever heard of anybody foolish enough to do this! No, the best bridge on the line of this railway, and one of the best bridges in New England, in my opinion, is one at Saugatuck, an economically built bridge it is too. It contains 835,303 lbs. of iron, cost $28,948; while Mr. JONES's bridge contains 2,742,765 lbs. of iron and cost, so I am told, $155,000. By "rule of three" the cost of the latter should be $28{,}948 \times 2{,}732{,}765 \div 835{,}303 = \$94{,}705$, a relative difference of more than $60,000. The difference ought to appear the other way, because the former bridge was of more expensive character. I am thankful for the opportunity given to point out this fact.

As to the assertion relative to approval of plans and strain sheets at the time of receiving proposals for the bridge: I would say that blue prints from two parties, showing simply strains and sections of the principal members of the proposed structure, were handed to me with instructions to go over the figures and see they were correct and sufficient. I was also instructed to state which of the two designs was the better one. No detail drawings accompanied these strain sheets, and no proposals. I was not asked to consider the element of cost or economy. In examining the section and strain sheets referred to I made use of a table of uniform live loads that were equivalent, with an allowance for impact to the actual loads that would be occasioned by a "Mogul" engine weighing 180,500 lbs. in a space of 57 ft. 5 in. instead of the "Consolidation" weighing 172,000 lbs. in a space of 55 ft., which was assumed as a basis in the strain sheets submitted. This table of uniform live loads showed the proper weight to be taken per foot up to 200 ft. For ten feet; it required 6600 lbs. per ft. or for 20 ft. 5500 lbs. For 18 ft. 9 in. it would require 5640 lbs. per ft. I found neither of the plans strictly up to what I considered requisite, though the one submitted by JONES & BENNER was nearly so and with slight corrections would be sufficient, and their design was in my opinion the simpler and better of the two. Now this was the substance of the verbal report that I made to the official of the railway who had given me instructions in the premises. I subsequently caused to be prepared a strain and section sheet showing what changes I had made; this strain sheet was forwarded to the contractors, I believe. Whether it was ever attached to the contract and specifications for this bridge and became a part thereof, I cannot say. I never have seen a copy of the contract and specifications. I urged upon the Vice President of the road who had charge, of the matter, the necessity of requiring the contractors to submit full detail drawings to be signed and approved before the work in the bridge shop was entered upon. No attention was paid to my suggestion. I was shorn of all authority in the premises, and reduced to a tool.

Now if there was a contract and if the strain sheet that I speak of was attached thereto, then the live load that the floor beam was required to sustain safely, in addition to the dead weight, without occasioning a stress of over rivet bearing and 4,000 lbs. viously noted, $5{,}640 \times 18.75 =$ of beam, and not 68,400 lb have us believe.

I come now to the kerne original strain and section the contractors for this br small sketch of the floor-b shown, was 42-ins. in dept plate was ⅜-in. thickness where it was shown $\frac{7}{16}$-in. in bridge the web of the bean depth and to ⅝-in. thickne just where section was mc ins. to 10½ sq. ins. A queer

As to the assertion that with this bridge until two years after it was completed, I say that assertion is untrue. As a matter of fact I was "kicking like a bay steer" all the while from the outset. The railway official who had the building of this bridge in hand was informed by me on two separate occasions before the bridge was completed, that the floor-beams were not what I supposed they were required to be. He simply did not believe it. He did not even believe it, when, having heard that another bridge similar to the one under discussion was contracted for, I went to him and ascertained that the report was true, and tendered my resignation, saying that I would not be mixed up in another transaction of this sort—though I then supposed that he did believe it, for he said that the beams would this time be of uniform depth throughout.

I append a copy of a letter to Mr. THEODORE COOPER, and an answer thereto in relation to the defective floor beam shown in your issue of 25 ult. It was obtained to send to a certain individual for the purpose of corroborating what I had said to him in regard to the defects noted. I gave the dead load upon each half of beam as 12,600 lbs. in the sketch sent to Mr. COOPER; a later revision led me to believe that 14,400 was nearer the correct amount.

Yours truly, J. E. BUDDINGTON.

[This correspondence, if it goes any further in these columns, must be free from personalities and personal questions, and confined purely to technical matters. We have allowed Mr. BUDDINGTON his say freely, since we allowed the same to his opponents, but there can be no further excuse for personalities which do not at all affect the question in dispute. What we have to say further in respect to the matter is said on another page.

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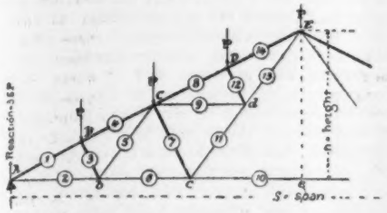

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8	0.9922	1.3229	1.6536	$-\frac{1}{\sqrt{n^2+4}}(\frac{1}{2}n^2+3) \times P$
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Although the writer is aware that he is treading a well-worn path, he cannot refrain from again recurring to an old question, one which, if he is not mistaken, has been touched upon by one of the present editors of the NEWS in a more or less extended article.

Is the English language, as spoken and written by the North American people, so poor that there can be found no word to distinguish between the man who controls a steam motor and the man who designed and constructed it? Can we not express, without explanatory foot notes, what we mean? May we not make a distinction between a man who is a master of the laws of applied sciences and a man who executes these laws, or manipulates a combination of applied forces to the end that those combined forces may be utilized?

In plain terms, may we not distinguish the *engineer* from the man who handles an engine? Parliament has recognized "Webster's American Dictionary of the English Language" as authority. Oxford and Cambridge have, as a consequence, declared it to be the standard upon which they base their understanding and teaching of the *idionta*, yet they, the Britons, do not confound the *engineer* with the *engine driver* either in print or in speech. It may be that this is more rigidly impressed upon a North American when abroad than when at home, for the reason that in none of the languages of modern Europe does he find this compound meaning, this conflict of ideas, this joint proprietorship of titles.

A foreigner, in reading a North American scientific journal, is constantly confounding the *engine man* with the *engineer*, and is in many instances in doubt as to which acceptation of the term to take, if, indeed, he knows there is but one. It may be repaired that the North American journals, either scientific or otherwise, are not written for foreigners. This, upon the "sufficient unto ourselves theory,"—a very narrow one, by the way—yet are we quite sure that, in all cases, the term *engineer* is not just a little ambiguous to the general reading public within the limits of our own territory? And more, we should so express ourselves, in print at least, that we may be clearly understood abroad, for at the present, the Anglo-Saxon is regarded abroad as far in the advance in engineering matters. "A rose may smell as sweet by any other name," but it ceases to be a rose. F. L. GRISWOLD.

[The confusion is unfortunate but it seems past curing. The *English* term "engine-driver" will never become naturalized in this country, and "engineman" although much used by "Engineers" is little used by any other class and is not likely to become general. A little niece of the editor of this journal, on learning that her prospective uncle was an engineer, expressed the hope that he might in time be promoted to conductor, and little ambiguities of that kind can hardly be avoided. The English have not precisely the same difficulty but they have a similar and greater one. The men whom we call machinists and the French, (as also the engine-driver) mècaniciens are known in England as Engineers. Every firm who do any kind of work in iron or steel are a firm of "Engineers" and every man in their employ is likewise an "Engineer" and belongs to the "Amalgamated Society of Engineers," if that is its precise title. After all, it is a small matter. "It pleases her and don't hurt me," said the man when his wife was beating him, and we may say the same.—ED. ENG. NEWS.]

Rail Exhibits at London and Paris.

WESTMINSTER, LONDON, July 8, 1887.

EDITOR ENGINEERING NEWS:

Being convinced that it is essential to the welfare of railway communication for safety, comfort and economy to introduce heavier rails and also that, because of the time it takes to break the ice and convert engineers out of their old grooves, no opportunity should be lost in laying before them facts—not in the form of papers, drawings or figures, but the actual thing—steel rails executed and laid upon tracks, I send you the following facts:

I have succeeded in converting the Belgium State Railway engineers to the use of a heavy Goliath rail, say about 100 lbs. per yd. They had it rolled at Seraing and laid upon the track between Brussels and Antwerp, with the good result that it is to be continued and adopted for all the main line system of railways in that country. It is, therefore, time to hope for sounder things, and consequently Messrs. COCKERILL have exhibited this heavy rail in Paris at the Centennial, and I in London at the American Exhibition.

I enclose a description of the former, the one in Paris—and have now to give you a short resumé of mine in London.

The object being the introduction of heavier flange-rails for all countries—I have taken a stand and invited all makers in America, England, Belgium, Germany and France to send short rail pieces of their heaviest sections for exhibition, free of all patents and of all charges—and I am happy to say the stand is well represented.

From America there are rails from Bethlehem Steel Works, and Joliet, neither, however, approaching in weight anything like the Goliath—There are English rails from Barrow and West Cumberland—90 lbs. to the yard; also rails weighing 80 lbs. from Rhymuey and Aberdale in Wales, and some lighter ones from Germany. Of course the 100 lbs. Goliath is the heaviest rail of the stand, but all countries are represented with a view to showing the different types of sections as well as the heaviest weight used in each, and so promote safety, economy and comfort, in fact, to let the permanent way grow in proportion to what the rolling stock has grown through the increased traffic, as there has come to be, rather a disproportion in many instances between the two divisions of railway plant.

Yours truly, C. P. SANDBERG.

The Goliath Rail.

19 *Great George Street, Westminster, S. W.*

LONDON, June 29, 1887.

EDITOR ENGINEERING NEWS:

Knowing the interest you have taken from the very birth of the Goliath rail, no one, I think, is more entitled to have the first news about its behavior in practice (that is to say, in making, laying and using) than yourself.

You have already published the fact about the facility in rolling and finishing. I have now to inform you equally good news about its being laid on the track, and finally upon the smoothness in running on it. I have assisted at all these operations on the Belgian State lines, and can speak with impartiality, notwithstanding I call it my Goliath.

There are a few more men wanted to lift it than are required for the lighter rails, but beyond that there is not the slightest difficulty in handling the rail from the make to the track. The run upon it is remarkably steady and smooth, so much so that it has astonished everybody; and although the whole of the trial rails are hardly yet laid upon the track, the authorities are so charmed with the idea that they have decided upon going in for another 1,000 tons this year, and may 10,000 next.

What can be more satisfactory to all those who assisted in promoting the idea, which, when first it was suggested, was merely regarded as a mad proposition? I can therefore only rejoice in presenting you with all the facts favorably connected with this scheme: the adoption of which will, without doubt, conduce to a better state of things.

Any remarks I may have to make upon the subject I will communicate to you from time to time as occasions occur.

I enclose you paper containing a few remarks bearing upon the matter, which you may feel inclined to publish. Yours truly,

C. P. SANDBERG.

PERSONAL.

J. N. BORST has been appointed Superintendent of the water-works at Cobleskill, N. Y.

C. W. FISHER, General Manager of the Chicago, Kansas & Nebraska R. R. has resigned, and will be succeeded by A. T. ROYCE.

J. M. ADAMS, President of the N. Y., P. & O. R. R. Co., has resigned, and C. E. WHITEHEAD, of New York, has been elected his successor.

Mr. GEO. H. FROST of this journal, accompanied by his son CHARLES, and his brother CHAS. B. FROST, sailed in the *State of Indiana*, for Glasgow, on the 21st.

Mr. ALBERT L. WEBSTER, Sanitary Engineer, has opened an office at 107 Drexel Building, New York, and will undertake surveys, the planning and construction of drainage and sewerage systems, and the investigation of and reporting upon the sanitary condition of buildings, towns, etc.

W. C. QUINCY has resigned his position as General Manager of the Pittsburg & Lake Erie R. R., and ELLIOTT HOLBROOK has been appointed General Superintendent.

H. W. DIGGINS is now Superintendent of the Arkansas division of the Kansas City, Fort Scott & Gulf R. R., from Springfield, Mo., to Memphis; and G. I. PERRY is Superintendent of the Kansas City Division, from Springfield to Kansas City. Mr. DIGGINS' office will continue at Springfield.

Mr. M. N. FORNEY, has sent in his resignation as Secretary of the Master Car Builders' Association, to take effect on or before Jan. 1, 1888. It is not known if the resignation will be accepted, but in view of Mr. FORNEY'S distinguished services in organizing and carrying on that Association it is not likely to be if it can be avoided.

CHARLES T. PARRY, the oldest member of the firm of the Baldwin Locomotive Works, died July 18. He was born at Philadelphia, Sept. 15, 1825, and entered the Baldwin Works as an apprentice, and in a few years became General Superintendent of the works. In 1867 he and GEORGE BURNHAM purchased the Baldwin interest and became partners in the firm of M. Baird & Co. Mr. PARRY was largely instrumental in bringing the works to their present condition.

W. G. RAOUL, President of the Mexican National Ry. Co., announces the following appointments: Col. D. C. DODGE, Vice President, at the City of Mexico; WM. M. SPACKMAN, Treasurer, and ANDREW ANDERSON, Jr., Secretary, at New York; GEORGE D. WADLEY, Superintendent of Construction, in Mexico.

Mr. JOHN B. KITCHING, an old New York merchant, died in New York on the 19th inst. at the age of 74. He gave $10,000 towards the construction of the first telegraph line in this country after the one built by Congress, took an active part in reference to the Atlantic cable, and was one of the first to befriend Capt ERICSSON when he was struggling for recognition. He lost a large sum in the Ericsson hot air motor.

General Superintendent SHEPARD, of the New York, New Haven & Hartford R.R., has established new divisions as follows: New York division, Superintendent, W. H. TURNER, New York; Assistant Superintendents, WM. H. WALLACE and W. J. CROSBY. Hartford division, Superintendent, C. S. DAVIDSON, Hartford, Conn. Shore Line division, E. G. ALLEN, New Haven. Air Line division, W. A. WATERBURY, New Haven. Northampton division, CHARLES N. YEAMANS, New Haven. Naugatuck division, GEORGE W. BEACH, Bridgeport. Valley division, J. V. A. TRUMBULL, Hartford.

SOCIETY PROCEEDINGS.

American Railway Master Mechanics' Association.—The following committees have been appointed to report at the next Annual Convention:

1. Relative Proportions of Cylinders and Driving Wheels to Boilers: CHARLES BLACKWELL, CLEM HACKNEY, J. M. MCGRAYEL.
2. Guides: JAMES N. LAUDER, W. J. ROBINSON, H. S. KOLSETH.
3. Extension Smoke-boxes, and Brick and other Fire-box arches: JOHN HICKEY, W. A. FOSTER, E. L. WEISGERBER.
4. Springs and Equalizers: JOHN MACKENZIE, J. S. PORTER, WM. SWANSTON.
5. Tires. Advantage or otherwise of using thick tires: J. W. STOKES, C. E. SMART, HENRY SCHLACKS.
6. Purification or softening of Feed Water: HERBERT HACKNEY, JOHN PLAYER, W. T. SMALL.
7. Prevention of dangerous escape of live coal and sparks from ash pans: G. W. ETTENGER, E. D. ANDERSON, W. H. THOMAS.
8. Tender Trucks: E. M. ROBERTS, H. D. GORDON, H. D. GARRETT.
9. Traction Increasers in Connection with Over-Cylindered Engines: J. DAVIS BARNETT, F. L. WANKLYN, T. J. HATSWELL.
10. The Magnetic Influence of Iron and Steel in Locomotives on the Watches of Engine-Runners: JAMES MEEHAN, HARVEY MIDDLETON, T. W. GENTRY.

Private Water Companies—Their Relation to Municipal Authorities and the Public.

BY H. F. DUNHAM.

[Read at the Seventh Annual Meeting of the American Water Works Association].

No one could attempt to prepare a paper upon a subject so important as the one assigned to me, without feeling a strong desire to know something about the work of those men who were the first to undertake the construction of water-works with private capital, and who, doubtless without suspecting it, introduced by their own success new opportunities for the exercise of judgment and skill in providing pure water for the public good. Not wholly out of place here would be a paper devoted to a description of the works established in 1581 by PETER MAURICE, who rented the first pier of London Bridge for five hundred years at ten shillings per annum, and the next season brought out the mayor and aldermen to see him throw water over St. Magnus' steeple, "the like of which had never been seen in all London before," and the like of which was not seen where promised in some of our cities 300 years afterwards. It would also be interesting to turn over the pages of some musty volumes, and make notes concerning "these plugs which are no sooner opened than there are vast quantities of water." And "this plenty of water has been attended with another advantage; it has given rise to several companies to insure houses and goods from fire; another advantage which is not to be met with in any other nation on earth." A little careful study might make it clear that the private water company and the municipal authorities were the happy parents of our modest and thrifty fire insurance company, but there are those better fitted for such investigations, and I trust they may be persued by some member at a future meeting, when it is to be hoped, the necessity for reference to what is being done in our own land may not be as great as it is now.

A large and, I think, an increasing proportion of the members of this Association are the superintendents of private companies. Some are in charge of works that were well designed and carefully constructed, and others in charge of works about which fewer good words can be said. Any discussion of the causes that operated to produce in one instance a good plant, and in another a very poor one, will be of interest to you all, and of such causes or influences it could easily be shown that those first exerted are likely to be the most potent. To this class, including the early negotiations between private companies and the authorities of cities, this paper will be limited.

In order to be more easily understood, and because I like the inductive method, of which an excellent example was set for me last season by one of your members, I will beg your attention to conditions that are liable to be met with, merely assuring you that I have not the creative genius of Cervantes and that I will not lead you to a pioneer city with a boom from which anything ridiculous might be expected.

You may call to mind a city of 3,000 or 4,000 inhabitants, pleasantly located upon a terrace overlooking a river into which a small creek flows. Within a radius of a mile or two there are two or three beautiful lakes. Good water power and railway facilities are available and the city and the surrounding country are in a prosperous condition.

At a September council meeting a stranger appears who says the city is large enough to have water-works, and mentions two or three towns where works have just been built. The mayor has for some time thought his city needed works; several members of the council have expressed the same opinion, and all see the force of one point made by the stranger. Up to that time water-works had never been built in their city, and might never be unless he (the stranger) built them at once. He would take water from the creek. It was curiously enough supplied from springs. He asks to have them appoint a committee to report at a special meeting as his visit must be short. Here let me introduce the official record of the special meeting.

"Hon. A. B. C. submitted the report of the committee appointed to examine the creek and its sources. As to the purity of the water there was no doubt in the minds of the committee; as to its volume they would not commit themselves, but merely submit measurements of the springs in full as follows:

Spring No. 1, 20 inches wide and 4-ins. deep. Nos. 2 and 3 each 12-ins. wide and 2-ins. deep. No. 4, 24 wide and 6 deep. No. 5, 16 wide and 6 deep. No. 6, 24 wide and 4 deep, and No. 7, 14-ins. wide and 2-ins. deep."

You will observe that no reference to velocity is included, and doubtless it was not thought of by the committee. Had they given weir measurements, spring No. 4 was flowing one and a half million gallons per day. They simply cross-sectioned so much more or less stagnant water. But to go on with the record;

"Dr. D. E. F. addressed the council upon the purity of water and suggested more time to consider the subject. A spirited discussion followed which developed an overwhelming sentiment in favor of Blank creek and a speedy execution of a contract for the erection of water-works."

The stranger departed with a franchise in which the city's interests were undesirably bound up for thirty years or more, and although he might succeed in disposing of it and securing through others the erection of works, the probabilities are that the company willing to pay the largest sum would build under it the poorest works and do the city the greatest harm.

But it may be urged that this is an instance of contract making without competition, and for that reason quite exceptional and not a fair illustration of actual conditions.

Let us turn over the record—imaginary, of course—of a larger city, population six thousand, where the subject of water-works has been under consideration for several months, and propositions from water-works companies have been solicited through the papers. The city lies upon a gentle slope in the center of a drainage area about one-third larger than the area of the city itself. The soil is a compact clay resting upon limestone, and the wash from the drainage area and the city streets forms, in a wet season, a small brook which crosses the corporation line through some low ground. Near this brook an old resident has an inexhaustible well. We will also assume that there is no suitable source of supply within a radius of three miles.

For a week previous to the date of opening bids there hung in the council chamber a large map of the city showing by heavy lines the location of the proposed pipes, and bearing in one corner an inscription like this: "*Hydrants eighty. Total pipe 9 miles, only 4 or 5 miles of which need to be of full size.*" It is further understood that the pumping station is to be built upon the low ground and within the city limits, otherwise it could not be taxed by the city.

When the bids are opened we need not be suprised to find that each competitor proposed to take water from the point designated by the city. Two of the bids received more attention than any of the others. They named substantially the same rentals and rates. One called for more elaborate and expensive machinery, and the other for a better pipe system and a large reservoir. Works constructed under bid No. 3 would cost about $30,000 more than works to comply with bid No. 1.

The representatives of the two companies, each with a few friends in the council, take in the situation at a glance. They have met before and may meet again, in another city. One is not quite certain but he described a reservoir larger than the city needs. The other is very positive that the city needs no reservoir at all. They work together with a common purpose and as one man.

Just here let us imagine— as no such thing would be likely to occur—that one bid was for taking water from a reasonable source three miles away, and for reasonable rental. There would not be a possibility of the acceptance of such a bid. The chances are ten to one that the best bid offered would be rejected, and that city, like the one already cited, would be burdened with a franchise in which it requires no engineering or other ability to read future mortality statistics.

I know that when errors are apparent in completed works, it is natural to cry fraud and to throw the whole blame at some one's feet, but this paper will fail in its purpose if it does not help us to a wider and in one sense a more charitable view. The bad and the indifferent works established throughout the country are but the natural results of influences, sentiments, business and unbusiness relations which could only be changed very slowly, and they are not well enough understood now to enable anyone to forsee or limit the absurdities to which they may give rise.

So long as municipal authorities are profoundly ignorant or culpably indifferent, it may be expected that some one will be ready to secure a seeming advantage. To educate and interest such bodies, changed as they are by every political breeze, and by every other breeze, is equivalent to educating and interesting the whole community. Turning to private companies, there is more to encourage us. Their standard, although advanced by their own efforts, chiefly, is being advanced. From an attempt to make the best possible trade, up to a determination to build only such works, in any city, as that city ought to have built, is a long step forward, and one that was not, or will not be, quickly made.

In the meantime, which is now, any safeguards that will help to diminish the number of ill-assorted contracts ought to be recognized, and that heedless parent, the State, cannot be too severely criticised for neglecting to provide and furnish to every city within her borders, such general directions about the character of the works required and the proper source of supply as would go far to ward off the hasty agreement and its ruinous results. In the absence of such assistance, organized individual labor would be of great services. Such careful works as that done by the Appalachian club in topography and geology, would have no less to commend it if it bore a still closer relation to the health of committees. Just how much should be undertaken by scientific men, and men of leisure, by chemists, engineers and others, I do not attempt to say, and I urge nothing unprofessional, although I believe that no man's opportunities are lessened by the patient accumulation of facts and the intelligent use of them. We know that when water rises into the atmosphere, it is watched by a hundred men, and very properly too, in its course from Puget's Sound to Eastport, if it goes so far, but after it falls to the ground it receives too little notice, unless its shadow darkens the page of some physician's journal. In the years before us this must be changed.

Englewood, N. J.—Water and sewerage systems are to be established. The water will be supplied by the Hackensack Water Co., and a company with a capital stock of $50,000 has been organized to build the sewers. A plan for a system of surface draining, at a cost of about $20,000, has been prepared.

Water Power.—It has been voted to issue bonds for the improvement of the water power at Little Falls, Minn.

STATISTICS OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated.)

CONTINUED FROM PAGE 47.

Mount Vernon, N. Y.—The works were commenced in May and accepted in Sept., 1886.; they were designed by GEO. B. INMAN, and W. E. ALLEN was Constructing Engineer. The contract for the entire work was taken by Inman Bros., New York. There is a Dean compound, duplex, condensing engine with a daily capacity of 2,000,000 galls.; two 50-H. P. boilers, built by Biglow, New Haven, Conn.; and a stand-pipe, 20 ft. diameter and 100 ft. high, built by John Cunningham, of Boston; the pipes and specials were furnished by the Warren Foundry & Machine Co., Phillipsburg, N. J., and the hydrants and valves by the Ludlow Valve Co., Troy, N. Y. The franchise is owned by the New York & Mount Vernon Water Co.; President, G. E. TAINTOR; Secretary, G. D. L'HUILLIER; Superintendent, E. H. SHEAF. The franchise is for 20 years and calls for 100 hydrants at a rental of $40. The present population is estimated at 9,000.

The water is taken from a reservoir on Hutchinson's creek, formed by excavating to gravel and building a dam across the valley; the area is about 1,500 ft. long by 400 ft. wide and the water is 4 ft. deep at one end and 9 ft. at the other. The supply is pumped by a Dean engine through a 16-in. cast-iron main to the stand-pipe, which is situated about 6,000 ft. from the pump, and just on the edge of the village, and from here it is conveyed to the center of the village by a 16-in. main. There are 15 miles of mains now laid, but additions are constantly being ordered; the contract called for 100 hydrants, but since then the contractors have added 38 and are still putting in more. The average pressure from the street pipes is 40 pounds, but in case of fire the stand-pipe is shut off and a direct pressure of about 150 pounds obtained. At the site of the dam the valley was 440 ft. wide, and the ground consisted of about 2 ft. of muck with 22 ft. of quicksand underneath. Across the entire length of the dam a row of sheet piling was driven through the quicksand into the blue clay under it, this being in order to cut off the flow of water through the quicksand. A trench 4 ft. wide was then dug through the muck down to the quicksand, and filled to the level of the ground with concrete; on this was built the center wall 2 ft. thick at the base and 18 ins. at the top, and reaching to within 1 ft. of the top of the embankment. This bank is 12 ft. high and 8 ft. wide on top; the outer slope is 1½ : 1 and the inner slope is 2 : 1 and is paved 1 ft. deep to prevent washing of the bank. The waste-weir was built in the body of the dam near one end, leaving a clear space 25 ft. wide for the overflow. The bed or body of the overflow is placed so that the center wall, if continued, would pass through the center; it is 9 ft. thick at the base, and 5 ft. at top, the top being 3 ft. below the top of the dam. The front is formed by stepping back from bottom to top with a set back of 12 ins. and a rise of 18 ins. to each step. The front sides are built of rough ashlar, carried down in steps, but to correspond with the outer slope. The two ends of the overflow are of rough ashlar, the full width of the dam at top, and inside they are carried down to the toe of the slope as wing-walls, the space between them being filled, sloped and paved like the other parts of the inner slope. Underneath the overflow is a 20-in. pipe, with valve, to be used as a mud pipe if necessary. It is proposed to raise the dam 3 ft., thus giving 7 ft. of water at the shallowest part.

Warren, O.—The works were commenced Nov. 10, 1886, and were accepted May 14, 1887; they were designed by ELLIS MORRISON, who was also Constructing Engineer. The contractors for the entire work were Samuel R. Bullock & Co., of New York, who performed the masonry, foundations, buildings, trenching, pipe laying and reservoir work. The pumping machinery was furnished by the Deane Steam Pump Co., Holyoke, Mass., the pipe and specials by R. D. Wood & Co., of Philadelphia; the valves and hydrants by the Eddy Valve Co., Waterford, N. Y., and the stand-pipe by Tippet & Wood, Phillipsburg, N. J.; the stand-pipe is 140 ft. high and 22 ft. diameter. The franchise is owned by the Warren Water Co.; President, E. WOLTMAN; Superintendent, GEORGE C. QUINBY. The franchise is for 20 years and the price per hydrant is $45. The present population is estimated at 6,000.

NOTE.—(*Correction*). The Builders Iron Foundry, Providence, R. I., write us that the specials for the water-works at Salem, O., were furnished by them to Turner, Clarke & Rawson, and not by the Cincinnati & Newport Iron & Pipe Co., as stated on page 47.

(TO BE CONTINUED.)

NOTE.—The above statistics of new construction are sent in response to special inquiries sent out by us to contractors, superintendents, engineers and others having to do with new works. We have a special blank for this service, and will be pleased to forward one or more on application. We invite co-operation in this special subject.

CONSTRUCTION NEWS.

Water.

Irrigation.—The Calaveras, Stanislaus & San Joaquin Irrigation Co. has been incorporated at San Francisco, Cal., by M. F. TARPEY, J. N. WOODS, J. GAMBERITA, W. E. GIBBONS and JOHN MCDONALD. Capital stock, $500,000.

Duluth, Minn.—The Duluth Gas & Water Co., is extending its gas and water works systems by laying about 7½ miles of mains for each; the pipes are from 4 to 20 ins. diameter. The pumping capacity is being increased by the addition of a Worthington duplex pump with a daily capacity of 5,000,000 galls.; and it is proposed to build 2 new reservoirs at elevations of 540 and 285 ft., the former for a high service system and the latter to replace the present reservoir. The generating capacity of the gas works is being increased. WM. CRAIG is General Manager and Treasurer.

Marinette, Wis—The City Council has rejected all the proposals received July 2 for the construction of a system of water-works; the reason for this action being that none of the plans for independent works could be carried out on account of legal difficulties. It is hoped by the citizens of this city and Menominee, Mich., that arrangements can be made with the Menominee Water Co., to enlarge its works and extend the system to Marinette, and thus give both cities double the fire protection that either could have alone. The large lumber interests demand this in order to provide security against future conflagrations.

Salem, Mass., has been having an experience caused by the giving out of a joint in its 20-in. supply main leading from Wenham Lake. Water had to be shut off from the town to repair the break, to the great inconvenience of its consumers, who use over 2,000,000 galls. der diem. The town of Peabody had a 15-in. connection with Salem, and turned on their water, but the pressure was so great that it caused numerous breaks in the Salem distribution, which is partly wrought-iron and cement-lined pipe.

Pueblo, Col.—The bonds for public improvements, $87,000, have been awarded to Preston & Co., of Chicago, at their bid of $88,752, a premium of $1,752. The bonds are for the following work: city hall, $35,000; bridges, $31,000; extensions of the sewer system, $11,000; levees, $10,000. Thirteen bids were received. A pipe line company is being organized to build refineries and pipe the oil from the Florence oil field, 21 miles west of the city, to Pueblo to be refined. J. H. CALDWELL is President of the company and the capital stock will be $150,000.

Water Works Improvements.—Springfield, Mass. The water has been shut off from the Belchertown reservoir in consequence of its foul condition, and a canal will be built to bring the water from Broad brook that formerly flowed into this reservoir.—Boston, Mass. Connections are to be made between the Cochituate distribution system and the Charlestown district, to give the latter a supply in case of emergency. The cost will be about $115,000.—Malden, Mass. Wells are to be sunk to obtain an additional supply.—Allegheny, Pa. Instead of building new works a filtering system will probably be established.—Sidney, O. Bonds for $80,000 for improvements are to be issued.—Richmond, Va. Superintendent BOLLING proposes to construct a filtering reservoir with a capacity of 125,000,000 galls.—Gadsden, Ala. The water company will expend $4,000 in improvements.—St. Louis, Mo. About $219,000 will be spent in improvements, of which $210,000 will be for extending the distribution system between Bissell's Point works and the Compton Hill reservoir; the balance will be for establishing electric lights at the works.—Lincoln, Neb. There is urgent need of an additional supply; recently the pumps had to be stopped to allow the well to fill up.—Omaha, Neb. New and larger mains have been laid and settling basins established. The present works are to be greatly extended and new pumping machinery put in.—Oakland, Cal. Work is in progress on the new distributing reservoir.

Water Waste.—At Chicago, Ill., the waste of water has become so great that that the water authorities are demanding that meters be placed in each house. JOHN A. MOODY, of the City Engineer's office, estimated the waste at 20 per cent. The engines pump about 124,000,000 galls. per day and the daily consumption is about 150 galls. per head.

Lancaster, Pa.—On July 7, J. J. R. CROES, Consulting Engineer, presented to the Council his report upon the proposed extension of the water-works. Mr. CROES' preliminary report has already been published in this journal, but having made further and more exact examination he reports two plans as follows:—No. 1. Including an inlet chamber, 9,600 ft. of 36-in. pipe and to attach to present Worthington pump the "high duty" device, $79,131; this includes right-of-way and work complete. Plan No. 2. Purchase of land, moving engines and engine-house; a 36-in. main to reservoir, new boiler and "high duty" attachment to pump, $81,380. Mr. CROES concludes that it is best to move the works as suggested by Plan No. 2.

Macon, Ga.—At the meeting of the Council on June 28, the question of the terms of the water contract was again discussed. Telegrams were read from Samuel R. Bullock, of New York, proposing that if council would delay making a contract for two weeks to a month, with a service of $9,000, sewer flushing extra, he would file a bond of $50,000 to begin operations at a given time. Telegrams were read from Savannah and Atlanta giving 15 and 17 cents per 1,000 galls. respectively as their rates. The result was that the 2 years contract was adopted, which provides for the payment by the city of $50 per hydrant up to 150, $45 per hydrant up to 200, and $40 per hydrant beyond 200.

Sewerage.—South Framingham, Mass. The Drainage Committee has decided to commence the construction of the new sewers. Engineer HEALD, of Worcester, who is making the surveys, will make his report in August and the matter will be brought up for action Aug. 15.——West Troy, N. Y. Owing to bad weather and other causes of delay the sewers will not be completed by November, according to the contract; 8 miles of the 18 are completed and work is progressing; the work will cost $75,000.——Trenton, N. J. The sewer ordinance has been approved by the mayor, and work will be commenced this fall. Plans and specifications will be prepared and proposals advertised for.——San Buenaventura, Cal. The election on the proposition to issue bonds for $20,000 for a sewerage system resulted in a favorable vote of 19 to 1.

Laconia & Lake Village, N. H.—The directors have presented their report for the year ending May 31, 1887, the first full year's business of the company. The combined amount of capital stock and bonds has been expended on construction, and future extensions, for which there is a demand, must be provided for by using the earnings or by borrowed funds. The net earnings are as large as could be expected. In Laconia there are 32,035 ft. of 12, 10, 8 and 6-in. mains, 6,301 ft. of 2, 1¼, 1¼ and 1-in. street extensions and side lines, 44 gates, 38 hydrants and 5 private hydrants. In Lake Village there are 22,797 ft. of 12, 10, 8 and 6-in. mains, 2,978 ft. of street extensions and side lines, 29 gates, 30 hydrants and 3 private hydrants. There 451 consumers. The total pumpage was 106,626,498 galls. The cost of the works is as follows: pumping station, pump, boiler, etc., $12,164.69; reservoir, $8,338.46; mains and hydrants, $57,741.97; extensions and side lines, $2,428.18; services, $3,734.89; tools, $323.57; meters, $62.31: office furniture, $125; total, $84,919.07. JOHN C. MOULTON is President, and EDWIN L. CHENEY, Superintendent.

Woonsocket, R. I.—The Water Commissioners have submitted their report for the year ending April 30, being the second annual report. There are now in use 18.963 miles of mains, 284 fire hydrants, 536 meters and 596 taps, supplying 1,551 families and 252 other consumers, with an average daily consumption of 243,565 galls., and a rental, including hydrants and water used for town purposes, of $21,203.74 per annum. This includes an increase for the year of 3,680.91 ft. of 4 and 6-in. mains, 14 hydrants, 172 meters, 160 taps, 393 families, 31 other consumers, and 51,565 galls. daily consumption. The works and plant are in good condition, but an additional pressure tank is recommended. The works were constructed in 1864. The supply is drawn from Crooked Falls brook and pumped to a tank. The pumping machinery was built by Henry R. Worthington, New York, and the total pumpage for the year was 89,423,053 galls. of which 34,638,525 galls. were metered. The mains are of cast-iron, 4 to 14 ins. diameter. The service pipes are of lead, ⅝ to ¾-in. diameter; there are 9,492 ft. in use; there are also 536 meters and 1 motor The range of pressure in mains is from 60 to 125 pounds The population is estimated at 19,500, with 16,200 on the lines of pipe and 7,755 supplied. The engine is a high pressure, duplex, direct acting, engine, with a daily capacity of 1,000,000 galls. WILLARD KENT is superintendent.

New Water Works.—*Maine.* Sorrento. The Frenchman's Bay Land & Water Co. will bring a supply from Long Pond, a distance of 3 or 4 miles. There will be a reservoir.——Fairfield. The Waterville Water Co. will make a proposition to supply water.——Thomaston. The water service for the State Prison has been completed.——*Massachusetts.* Mansfield. The town having failed to adopt the charter granted by the Legislature, the works will be built by the Mansfield Water Co.——Plymouth. It is proposed to improve the supply and divide it into a high and low pressure service.——*New York.* Waterville. The estimated cost of the system is 140,000. W. B. RIDER is the engineer to Water Commissioners.——Dansville. It is proposed to build new works; the present system is in wooden logs and is only used for fire purposes.——Cobleskill. The Water Commissioners have made their final settlement with contractors Stanton & Doyle; the total cost of the works is about $60,000.——*New Jersey.* Mount Holly. A company has been organized to erect new works, in consequence of the complaints of the foulness of the present supply.——*Pennsylvania.* Washington. Waterworks are being built; water will be pumped by a wind engine from a series of wells to a reservoir of 3,000,000 galls. capacity. There will be 7 miles of pipe and pipe laying has been commenced. SAMUEL HAZLETT, of Washington, is President. —— *Maryland.* Catonsville. Pipe laying will be commenced next month.——*Kentucky.* Winchester. A proposition has been made to build works.——*Mississippi.* Vicksburg. The waterworks company has abandoned the attempt to obtain water from wells, and will pump the supply from the Mississippi river.

Minnesota. Anoka. A system of water-works will be put in at a cost of about $40,000.——Austin. The council has agreed upon the plans and specifications for the new works and will advertise for proposals. The cost will be about $40,000, for which the city will be bonded.——Sleepy Eye. A complete system of water-works will be established.——Rochester. The franchise calling for the completion of the work by July 1, has been extended to Sept. 1.——*Wisconsin.* Washburn. Proposals for the new works were opened this week.——*Missouri.* Macon. During a recent agitation for water-works 4 propositions were presented, and one of them was hastily accepted by the Council to be voted on by the citizens. Subsequently it was found that the franchise and contract were very loosely drawn up, the proposition was withdrawn and the election cancelled.——*Kansas.* Water-works are contemplated at Baxter Springs and Stafford.——*Arkansas.* Newport. The new works have been accepted by the town council.——*Nebraska.* Seward. The issue of $21,000 in bonds for water-works was defeated on election owing to dissatisfaction at the indefinite plans for the construction.——*Colorado.* Loveland. Water has been turned on, though the works are not quite completed. They will be tested shortly.——*Montana.* Helena. Ground was broken at the reservoir on July 6; the trenching and well digging are in progress and the machinery is in position.——*Texas.* Weatherford. The city is contemplating putting in water-works.——Goldthwaite. It is proposed to sink an artesian well for a water supply.——Sherman. The mayor has been instructed to take charge of the works and to make the 30 days test, if the contractors refuse to make it, and see if the guaranteed amount has been obtained.——Waco. It is reported that Inman Bros. will not build the new works, and it is now proposed to bond the city for $15,000 and build and operate a system.——*Canada.* St. Thomas, Ont. It is proposed to experiment with the Andrews drilled well system for a water supply.——Inman Bros., of New York, are erecting water-works at Osage City and Council Grove, Kan., and at Decatur, Ala. Work is approaching completion on the two former and material is being delivered for the latter.——Moffett, Hodgkins & Clarke, of Watertown, N. Y., propose to build works at Spartanburg, S. C., and Goldsboro, N. C., this season

Proposals Open.

Sewers.—PERCIVAL W. ST. GEORGE, City Surveyor, Montreal, Canada. July 27.

Sidewalks and Wooden Bridge.—N. S. GROFF, City Clerk, St. Paul, Minn. July 27.

Paving.—Belgian block pavement and bluestone curb. GEORGE R. CONNER, Commissioner of City Works, Municipal Building, Brooklyn, N. Y. July 28.

Street Work.—Regulating, grading, curbing and Belgian trap block and granite block paving; taking up and relaying pavement. JOHN NEWTON, Commissioner of Public Works, 31 Chambers street, New York City. July 28.

Sewers.—Brick sewers, 1,200 ft.; cement pipe sewers, 5,300 ft.; manholes, etc. Specifications at the office of STOCKWELL BETTES, C. E., Fort Block. E. S. FLOWER, Chairman of Selectmen, West Springfield, Mass. July 30.

Bridges.—Two bridges; plans and specifications on file in the office of the county clerk. THE CLERK OF THE BOARD OF SUPERVISORS OF SUTTER COUNTY, Yuba City, Cal. August 1.

Street Work and Sewer.—Regulating, grading, curbing, flagging and crosswalks: brick sewer, 28×42 ins.; 12-in. pipe sewer, manholes, basins, concrete, etc. THE PARK COMMISSIONERS, Department of Public Parks, 49-51 Chambers street, New York City. August 1.

Sidewalk.—Price per lin. ft. for flagging sidewalks complete, including excavation, filling, etc. THOS. J. LANAHAN, Clerk, Board of Contract and Apportionment, Albany, N. Y. August 1.

Lining Reservoir.—East Park reservoir. Proposals for concrete floor and brick slopes, or concrete to within 20 ft. of the top and the balance brick. THE DIRECTOR OF PUBLIC WORKS, Philadelphia, Pa. August 2.

Canal Work.—Locks 34, 35, 72 Erie canal, and 4 and 7 Oswego canal, to be lengthened. Plans and specifications at the office of the Superintendent of Public Works, Albany, and the Division Engineers at Syracuse and Rochester. JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y. August 2.

Pipe Sewer.—At Clyde, N. Y. JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y. August 3.

Bridges, Road Work, Etc.—Masonry and wrought-iron superstructure for 2 bridges; road improvement; 1,756 cu. yds. of gravel. Plans and specifications on file. FRED. RAINE, County Auditor, Cincinnati, O. August 6.

Bridge.—Two sandstone abutments, approaches and iron superstructure. SAMUEL M. PRUGH, County Auditor, London, O. August 9.

Railroad.—From Saltillo to San Luis Potosi. C. A. MERRIAM, Superintendent, Mexican National Ry., Laredo, Tex. August 10.

Tank.—Iron water tank on concrete foundation, at Jefferson Barracks, Mo. Plans and specifications on file. C. W. FOSTER, Quartermaster, U. S. A., St. Louis, Mo. August 12.

Bridge Piers.—For the new Harvard bridge across the Charles river, between Boston and Cambridge. From 20 to 23 ashlar masonry piers with pile foundations. Plans and specifications at the office of the City Engineer, Boston. THE COMMISSIONERS OF THE HARVARD BRIDGE, City Hall, Boston, Mass. August 15.

Bridge.—Highway bridge across the Eastern branch of the Potomac river, at Pennsylvania avenue, Washington. Lieut. Col. PETER C. HAINS, U. S. Engineer Office, Washington, D. C. August 16.

Contracting.

The California Bridge Co., with main offices at San Francisco, Cal., will erect extensive works at Oakland, Cal. A. W. BURRELL, of Oakland, is President.

Water-Works.—Moffett, Hodgkins & Clark, of Watertown, N. Y., have been awarded the contract for works at Spartanburg, S. C. The supply will be drawn from two small streams and is guaranteed to be of good quality. The town will be supplied by January next. The city will pay $2,800 per annum for 56 hydrants.

The only proposal received by the Council, Lincoln, Neb., July 6 for an additional supply of 2,000,000 galls. per day was from Jos. Burns, for $6,855 in accordance with plans submitted. It was referred to the City Engineer and the Water Commitee. The present supply is inadequate and is giving some trouble, W. J. COOPER is Chairman of the Committee.

The contract for the proposed water-works at Jerseyville, Ill., has been awarded to GEO. C. MORGAN, of Chicago, at 229,899. He has also the contract for the works at Lewistown, Ill., for $24,900.

The following proposals have been received at St. Cloud, Minn., for the purchase of the water-works: Hiram Upham, Minneapolis, $15,000; H. W. Phelps and E. T. Sykes, Minneapolis, $19,000; C. E. Gray, Fergus Falls, $20,000.

A. L. Strang, of Omaha, Neb., has been awarded the franchise for water-works at Norfolk, Neb. There will be 50 hydrants, and the annual rental will be $3,000.

Outlet Sewer.—The following proposals for the construction of a brick outlet sewer with pile foundations, at the U. S. Carp Ponds, have been received by the U. S. Fish Commission, Washington: Morris Murphy & Co., $4,997; McLaughlin & Davis, $6,984; Jas. B. Haliday and Wm. A. Wilson, $3,650.

Street Work.—The following proposals were received July 13 by the Board of Public Work, Duluth, Minn.: John Butchart, $25,423; J. H. Keiver, $26,374.50; Wm. McLelan, $26,946; J. S. Wolfe, $28,613. The contract was awarded to John Butchart at the following prices: rock and earth excavation, $1.45 and 32 cts. per cu. yd.; gravel, 85 cts. per cu. yd.; timber gutters, $18.50 per 1,000 ft. B. M.; rip-rap, 50 cts. per cu. yd.; 24-in. pipe, $2.50 per ft.; relaying sidewalk, 10 per ft.

Sewers.—At Cambridge, Mass., the contract has been awarded to E. F. Bowker as follows: wooden outlet, 22 by 22 ins., $1.50 per ft.; single ring brick, 23 by 25 ins., and 19 by 21 ins., $1.70 and $1.20; 12 and 10-in. Akron sewer pipe, 65 cts.; tide gate manholes, $300; slants on brick, 25 cts.; inlets in pipe, 65 cts.; manholes, $27; total, $2,262.20. The other bidders were A. H. Bryne, $3,375.63; P. O'Connor, $3,809.

Pipe Laying.—At Jamestown, Dak., the contract for laying water-mains has been awarded to M. Hockers, of that city. Kalamein pipe, 6 ins. diameter, will be used, and the contract price is $4,360 for 2,500 ft of mains, with all fittings. Nine bids were received.

Bridge Contracts.—At Seattle, Wash. T., contracts for pile bridges have been awarded as follows: Tolt river bridge (mostly filling across 3 channels) T. W. Lake, of Seattle, $2,140; White river bridge, California Bridge Co., Oakland, Cal., iron swing bridge and approaches, $3,900. LYMAN WOOD, County Auditor.

At St. Paul, Minn., the contract for the Mohawk avenue bridge was, after considerable wrangling, awarded to the Keystone Bridge Co., at $340,324, while the bid of the Morse Bridge Co. was $324,000. According to the local papers, however, the entire business will have to be gone over again, as the bid was made by Mr. STROBEL, representing the Keystone Co., but as he arrived too late to get a power of attorney from that company he made the bid in his own name, and the contract will have to be awarded to him, as the Keystone Co. did not make any bid nor file bonds. City Engineer RUNDLETT had recommended the award to the Morse Bridge Co.

At Lancaster, Pa., the contract for a bridge over Hoffman's Run was awarded to Joseph Licht at $374 and $3 for each extra perch of stone.

The following proposals for a bridge over the Passaic river were opened July 6 by C. F. HARRINGTON, Chairman, Joint Committee of Bergen and Essex counties, Kingsland, N. J.: Superstructure: Passaic Rolling Mill Co., Paterson, N. J., $14,185: Wrought Iron Bridge Co., Canton, O., $18,300. Substructure: A. E. Sanford, $17,500; John Slattery, $20,660. All the proposals being higher than the amount appropriated by Bergen county, the committee will ask further instruction from the Boards before taking action.

The following proposals have been received for an iron bridge, 36 ft. span, across the Fallkill, at Poughkeepsie, N. Y.: Curtisville Foundry, Stockbridge, Mass., $1,491.70; Berlin Iron Bridge Co., East Berlin, Conn., including asphalt paving, $5,325, (alternative bids, $2,590, $2,100): Groton Bridge Co., Groton, N. Y., $2,620; King Iron Bridge & Manufacturing Co., Cleveland, O., $2,480, (if city furnishes helpers, $2,430).

Concrete Foundations.—The following proposals for the concrete foundations for the Congressional Library at Washington, D. C., were opened July 9 by the Commissioners for Construction: H. L. Cranford, $5.87 per cu. yd, (Portland cement); Thomas H. Lyons, $6.50 (Portland); Wm. F. Wheatley, $4.93 (Portland), $3.22 (Cumberland American); Morris Murphy, $7.34 (Portland); Michael Shea, $5.85 (Portland); T. H. Steep & F. Baldwin, $4.74 (American), $6.39 (Portland). For the whole work, Jacob H. Dewees, $107,700 (Portland); Albert Gleason, $97,500 (Portland); F. E. Barnes, $89,990 (Portland); H. J. McLaughlin, $97,500 (Portland), $74,000 (American). J. L. SMITHMEYER is the architect of the building.

Pumping Engines.—The only proposal received July 8 by the Water Commissioners, Buffalo, N. Y., for a pumping engine with a daily capacity of 20,000,000 galls., including boilers, etc., was from the Holly Manufacturing Co., Lockport, N. Y.; with 4 boilers, $95,750; with 6 boilers, $99,750.

Mr. LESAGE, Superintendent of Water-Works, Montreal, Canada, estimates the cost of boilers, engines and pumps for both stations, for preventing future inundations, at $38,000, which is within the $46,000 appropriated. The specifications have been agreed upon, and proposals will be advertised for.

The Holly Manufacturing Co., Lockport, N. Y., has been awarded the contract for two pumping engines and boilers for the U street pumping station, Washington, D. C. The daily capacity is 2,500,000 galls. against a head of 140 ft. The guaranteed duty was 90,000,000 foot-pounds per 100 lbs. of coal.

Bridge.—The following proposals have been received for the construction of the highway bridge across the Missouri river at Great Falls, by J. T. DODGE, Chief Engineer, Great Falls Townsite Co., Helena, Mont.: San Francisco Bridge Co., $17,250 (all iron), $14,600 (combination); Mount Vernon Bridge Co. Mount Vernon, O., $17,994, $13,975; Kansas City Bridge & Iron Co., $20,500, $15,350; Milwaukee Bridge Co., $21,556, $13,775; Pacific Bridge Co., $22,727, $15,610; Missouri Valley Bridge & Iron Works, Leavenworth, Kan., $23,300, $18,000; Wrought Iron Bridge Co., Canton, O., (all iron) $14,317 (below requirements of specifications); Phœnix Bridge Co., Philadelphia, (all iron) $21,150. The bids for masonry ranged from $17 to $36 per cu. yd. The bridge will consist of 9 spans of 160 ft. each, and the roadway will be 20 ft. wide.

Pumping Engines.—The following proposals were received recently by the Water Board, Allentown, Pa., for two steam pumps with a daily capacity of 9,000,000 galls. against a head of 210 ft.; Knowles Steam Pump Works, New York, $17,900; Holly Manufacturing Co., Lockport, N. Y., $24,000, $35,000, $13,500 and $17,500 under specifications A, B, C and D; Gordon & Maxwell, Hamilton, O. $30,000; Davidson Steam Pump Co., New York, $24,700, including boilers; Deane Steam Pump Co., Holyoke, Mass., $21,300 and $19,600 under specifications A and B; Robert Wetherill & Co., Chester, Pa., $34,000; Worthington Steam Pump Co., New York, Nos. 1, 2, 3, $29,700, $22,500, $15,500; Southwark Foundry & Machine Co., Philadelphia, $21,494. The contract was awarded to the Knowles Steam Pump Works at $17,900 exclusive of the the boiler. S. D. LEHR is City Engineer.

Asphalt Paving.—The Barber Asphalt Co. has sent a communication to the City Council of Chicago, Ill., making a proposition to pave any of the streets and alleys with a Trinidad sheet asphalt pavement for $5 per sq. yd.; to be kept in good condition for 25 years and the work to be done under the supervision of the Department of Public Works. The average price paid during the last five years for the wooden pavements used in the city the communication estimates to be—including the necessary grading—$1.25 per sq. yd. The average life of a wooden pavement is placed at five years, a portion of which time it is in very bad condition. To keep a street well paved with wood for a period of 25 years would require the laying of six pavements at a total cost of $7.50 per sq. yd. To keep up a street well paved with granite for 25 years would require the laying of two pavements at a total cost of $7.20 at least. It is stated in conclusion that the pavement referred to is radically different from the various pavements made of coal tar and supposed to be asphalt which have been laid in at Chicago.

Bridge Contracts.—The King Iron Bridge & Manufacturing Co., Cleveland, O., has the contract for an iron bridge of 135 ft. span across the middle branch of the Westfield river at Huntington, Mass.

The following proposals have been received at Rome, N. Y.; Groton Bridge Co., $2,269; Berlin Iron Bridge Co., $2,254; Canton Wrought Iron Bridge Co., $2,190; King Iron Bridge & Manufacturing Co., $2,285.

The Detroit Bridge & Iron Works Co. has been awarded the contract for the Belle Isle bridge at Detroit, Mich., for $280,000.

At Portland, Ore., the contract for a bridge 310 ft. long has been awarded to O. P. Lent at $754.

The St. Louis Bridge & Iron Co. has been awarded the contract by JULIUS RAPP, Commissioner of Roads & Bridges, Clayton, Mo., for 7 iron Pratt truss bridges; ranging from 39 ft. at $500 to 65 ft. at $950. The aggregate bid was $4,560.

At Leavenworth, Kan., the contracts for 9 county bridges and a culvert have been let to Chas. H. Chapin at an aggregate of $3,545.50. J. W. NIEHAUS, County Clerk.

Sewers.—*Norwalk, Conn.*—The following proposals have been received for the construction of Sub Division No. 1 of the general sewerage system: George W. Cram, Norwalk, $33,608.10; Francis Leonard, Norwalk, $34,547.50; Wm. E. Dean, New York, $37,657.83; A. Bragos & Sons, Middletown, Conn., $38,374.38; John Bogart & Co., Brooklyn, N. Y., $44,311.91; Luther W. Burt, Hartford, Conn., $45,019.85; Thomas Newman, Brooklyn, N. Y., $45,200; James Campbell, Hartford, $38,901.14 (informal); Delos E. Culver, New York, $37,821.29 (informal). The contract was awarded to George W. Cram, at the following prices; brick sewer; 66-in., $12 per ft.; 60-in., $7.50; 48 and 42-in., $6.50; 24-in., $2.75; stoneware pipe, 24-in., $2.25 per ft.; 18-in., $1.35; 15-in., $1.15; 12-in., 80 cts.; 6-in. house connections, $1.49 each in stoneware or cement pipe sewer, 20 cts. each in brick sewer; manholes, complete with iron head and cover, $55 each; street basins, with iron cover, $45 each; catch basin connections, 25 cts. per ft.; 10-in. catch basin connections, 40 cts. per ft.; rock excavation $4 per cu. yd. Plans and specifications are being prepared for the other sub-divisions and bids will soon be asked for.

Green Island, N. Y.—The contract has been awarded to Van Vranken & McGowan, of Green Island. (For details of bids see page 48).

Newark, N. J.—The intercepting sewer and pumping works will be examined and reported on for the Sewer Committee by A. M. WORTHEN, President, Am. Soc. C. E., and Engineer A. FTELEY, of the New Croton Aqueduct.

Pittsburg, Pa.—The Negley Run sewer contract has been rescinded and the work have been abandoned.

Lancaster, Pa.—Contracts have been awarded as follows: D. Kitch, $360, $335, $333, $263 and $326. D. Bouder, $257.

Newark, O.—The contract for 1,315 ft. of sewer has been awarded to J. C. Murray at $6,575

Birmingham, Ala.—A sewer contract has been awarded to John McPoland at $29,000.

Detroit, Mich.—The lowest bidders for lateral sewers were Louis Smith, F. Porath, John Affeld, T. G. Whittaker and Robert Borchard. The lowest prices on different sections ranged from 60 to 95 cts. per lin. ft.

Montreal, Canada.—The following contracts have been awarded: M. O'Conner, $7,69, $7.85; Jeannette & Bellehumeur, $6.75, $12.50. Others to John Parker, J. Laporte and James Cochrane.

Street Work.—*Detroit, Mich.*—The following proposals for wood and stone paving have been received by the Board of Public Works: Eugene Robbins, wood, $1.15 per sq. yd.; stone, $1.14; total, $21,869.17. Talbot Paving Co., $1.15, $1.20, $21,921.21. S. R. Thompson, $1.18, $1.20, $23,135.58. Ledbeter & Stewart, $1.18, $1.18, $23,197.05. Henry Woodson, $1.19, $1.17, $22,874.53.

Hyde Park, Ill.—Contracts for street improvement have been awarded as follows: Daiese & Shepard, $31,500, $1,500, $5,500 $10,550, $7,100; R. E. Brownell & Co., $8,500, $6,250.

Kansas City, Mo.—Contracts for cypress block paving have been awarded to Geo. J. Baer at $1.50 and $2.24 per sq. yd. Grading contracts have been awarded to P. Keating, J. O'Flaherty, Comstock & Williams, L. Morely and T. C. Lidwell; the prices were about 65 and 35 cts. per cu. yd. for rock and earth excavation; $1.50 per ft. for 18-in. pipe, $4 per cu. yd. for concrete, 25 cts. per cu. yd. for embankment. Curbing contracts were let to J. J. Armstrong. Sidewalk contracts were let to O. F. Redman, 30 and 41 cts.; R. D. Glenn, 29 cts.; Thomas Kneaves, 30 cts.; B. G. Thompson, 35 cts.

The Ingersoll Rock Drill Co., New York reports a steady increase in its business. Complete mining plants have recently been supplied to the Dallas Mining Co., of Dallas, Ga., and the Briarfield Coal Co., of Briarfield, Ala.; and some creditable work has also been done among the contractors on the Canadian Pacific Ry.

Steel Gun Forgings.—The following are the particulars of the bid of the Midvale Steel Co., Philadelphia, submitted to the Secretary of the Navy: For furnishing the forgings rough-bored and turned, oil treated and annealed: tubes and jackets for 6-in. B. L. R., 31.83 tons, $885 per ton, $28,169.55; hoops for 6-in. B. L. R., 26.48 tons, $885, $23,434.80; trunnion bands for 6-in. B. L. R., 2.68 tons, $1,344, $3,601.92; plugs and mushrooms for 6-in. B. L. R., 1.040 tons, $800, $832; hoops for 10-in. B. L. R., 3.191 tons, $1,232, $3,931.31; total, $59,969.58. If the tubes, jackets and trunnion bands are to be rough-bored and turned by the Department, the prices will be as follows: tubes and jackets, $716.80 per ton, $22,815.74; trunnion bands, $885, $2,371.80, other details the same; total, $83,385.65.

Dredging.—The contract for dredging in the harbor at Toronto, Canada, has been awarded to I. Conlon, of Thorold, Ont., at 15 cts. per cu. yd. in dump scow, and 28 cts. per cu. yd. in flat scow, for filling in.

The following proposal for dredging the North river bar, N. C., was opened July 11 by Capt. F. A. HINMAN, U. S. Engineer Office, Norfolk, Va.: Atlas Dredging Co., Wilmington, Del.; 25 cts. per cu. yd.

The following proposals have been received by JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y.: At Parda Hook; Charles Brown, 10¾ cts. per cu. yd.; E. M. Payn, 15.9 cts.; P. W. Myers, 16¾ cts. At Bogart's Light: Charles Brown, 11¾ cts.; E. M. Payn, 17.9 cts.; P. W. Myers, 17 cts. At Stuyvesant, C. Brown, 9¾ cts.; P. W. Myers, 16¾ cts.

The only bid received at the Department of Docks, New York, July 18, for dredging at piers 12, 13 and 14, East river, was from the Morris & Cumings Dredging Co., 22 cts. per cu. yd.

Railroad Contracts.—James Isbester, of Ottawa, Canada, has been awarded the contract for the second section of the Cape Breton Ry., from the strait of Canso to Grand Narrows. The contract price is about $1,250,000.

Foster, Creighton & Co., of Nashville, Tenn., have about 30 miles of work on hand for the Nashville, Chattanooga & St. Louis Ry. Co.

Drew, Lewis & Co., of Niagara Falls, have the contract for double tracking the Grand Trunk Ry. between Lansdowne and Gananoque, 9 miles; T. B Raphael & Co., of Ottawa, have the 2¼ miles between Scarboro and York; Ross & McRae have the ten miles between Vaudreuil and Coteau, and the company will do the work between Montreal and Lachine. Proposals will soon be open for the line from Lachine to Valois, and when this is finished, it is expected the Victoria bridge will be double tracked.

Horace Scott and John D. Lyle, of Columbus, Ind., have commenced work on the Air Line branch from Lincoln to Tell City, Ind.

C. H. Ryan, of Russellville, Ky., has the contract for the Central City & Sacramento R. R.

The subcontracts for the Red River Valley Ry., in Manitoba, have been let to M. Strevel, 26 miles; Egan Bros., from the commencement to the Strevel contract; Bryson & Irvine for the remainder.

McCarthy & Kerrigan, of Little Rock, Ark., have the contract for the branches of the St. Louis, Arkansas & Texas R. R., from Altheimer to Little Rock, Ark., and from Louisville to Shreveport, La. Sub-contracts have been let to the Penitentiary lessees at Little Rock, C. E. Downs, T. Tate, and Burns & Fitzpatrick.

John A. Prentice, of Palatka, Fla., has the contract for 75 miles of the Alabama, Florida & Atlantic R. R.

Nelson Bennett has the contract for the construction of the Oregon Pacific R. R., east from Albany to the Cascade mountains.

RAILROADS.

East of Chicago.

Existing Roads.—*Waterbury & Meriden.*—Grading is in progress on this Connecticut road, and it is expected to be open for business in December. J. H. CRAWFORD is Chief Engineer, and V. F. VALDEZ, Principal Assistant.

New York, New Haven & Hartford.—The city of New Haven is much exercised over the prospective loss of this company's shops and offices. The company has at present over 5,000 employés, which with their families would form a good sized town, but whose loss would be severely felt by New Haven. At the recent meeting of the company, the leases of the Stamford & New Canaan, the Naugatuck, the New Haven & Northampton, and the Hartford & Connecticut Valley were all ratified. In speaking of the prospect of a parallel line, Mr. W. D. BISHOP said: "A rival road may come. In the course of years it will come. But whoever imagine that they can build a road to rival the Consolidated for anything like the amount of its capital stock and debts are wofully mistaken. It is certain that any road that parallels the New York, New Haven & Hartford will become bankrupt or pass under its control."

Pittsburg & Western.—This company has been having a lively little combat with the city officials of Youngstown, Ohio. Tracks were laid by the company across Mill street and the crossing was held by a train and 200 employés of the company. The city council, regular and special police, and the fire department went in a body to take possession of the crossing. The persuasive eloquence of a couple of streams from a hydrant caused most of the railroad men to retreat and the rest were clubbed away by the police. The engineer was fired out of the locomotive and when the engine and train were moved off, the crossing was torn up. The company will sue the city for damages.

Chateaguay.—A charter has been filed for the extension of this line in the Adirondack region, mentioned two weeks ago. EDWARD HALL of Lyon mountain is Chief Engineer.

Fitchburg.—At North Pownal, Vt., the old Troy and Boston track, which always gave trouble in high water, is to be thrown up; and the entrance over the Boston, Hoosac Tunnel & Western will be double tracked. Rumors are afloat that this company is to be closely identified with the Vanderbilt system.

New Projects & Surveys.—*Carbon, Schuylkill & Western and Clearfield & Allegheny.*—These mysterious lines, whose incorporation in Pennsylvania was reported last week, seem to be of the same substantial character as the modest corporations that are borne so profusely on Kansas soil. The incorporators are generally unknown, and while one GEO. A. STIMSON is said to own some $20,000,000 of the capital stock, it is thought that if anyone can find him, he would be kind enough to let his friends in on the ground floor at something off from par. Mr. J. J. SUMMERS the President says," Moneyed men are behind the projects and the roads will be built. Some preliminary surveys have been made already."

Washington County.—This company has been incorporated in New York to build a railroad from Greenwich to New Granville, 36 miles. The road will connect with the Fitchburg at State Line, JOSIAH G. CHASE, Cambridgeport, Mass., is interested.

Allegan & La Porte.—A project is being agitated for a railroad from Allegan, Mich., to La Porte, Ind.

Clinton Air Line.—It is rumored that this long abandoned project in the northern part of Trumbull county, Ohio, is to be taken up and completed. THOS. L. SCOTT, Erie, Pa., is interested.

Mohawk & Susquehanna Valley.—This new company has been unsuccessful in its effort to lease the Cooperstown & Susquehanna road. It is proposed to begin work on the road at an early day.

Ft. Plain & Richfield Springs.—Despite the assertions of its rival that this company has no capital behind it, it is keeping up the fight vigorously, and making preliminary surveys. WM. CLARK of Fort Plain is President, and JOHN M. FARLEY, Chief Engineer.

Niagara Central.—The Canadian Pacific is using its influence to defeat this scheme.

Mt. Vernon, Coshocton & Wheeling.—It is reported that this road, projected from Marion, O., to Wheeling, W. Va., which has been on the tapis so long is to be constructed at once with the aid of "English capital." G. A. JONES of Mt. Vernon, O., is President.

Southern

Existing Roads.—*Savannah & Tybee.*—This suburban road at Savannah, Ga., has been completed and opened for business from Savannah to Tybee island, 16 miles.

Louisville Southern.—The officers of this line, now under construction from Louisville to Danville, Ky., have offered to extend it from Danville to Richmond for $300,000.

East Tennessee, Virginia & Georgia.—The engineers' work is nearly done on the extension of the Memphis & Charleston to Chattanooga, Tenn., and grading will begin soon. A line is proposed to Rockwood, Tenn., running up the Sequahatachie valley.

East & West of Alabama.—Tracklaying has begun on the extension from Broken Arrow to Pell City on the Georgia Pacific.

Jacksonville, Tampa & Key West.—This company will unite with the South Florida company in building a large union depot at Sanford, Fla.

Florida Midland.—It is reported that work has been stopped on the extension of this company's line on account of pending litigation.

New Projects and Surveys.—*Virginia Western.*—The locating surveys of this line are in progress. It is stated that grading will be begun soon near the eastern terminus at the connection with the Richmond & Alleghany.

Clinton & Big Valley.—This company has been incorporated at Knoxville, Tenn. The line will connect with the Walden's Ridge road.

Mobile & Hattiesburg.—JOHN KEMPER, of Evergreen, Ala., is interested in a project for a railroad from Mobile, Ala., to Hattiesburg, Miss.

Charleston, Kentucky & Western.—J. S. SPAULDING, of New York, is endeavoring to secure county subscriptions to this line in Kentucky.

Hartford & Tichenor.—A railroad is proposed between these towns in Kentucky, a distance of 14 miles. The latter is on the Owensboro & Nashville line.

Cincinnati, Huntsville & Birmingham.—A branch is proposed from Florence to Fayetteville, and it is stated that a survey will be made about Aug. 1.

The Northwest.

Existing Roads.—*Detroit, Lansing & Northern.*—Grading is in progress on the extension from Grand Ledge to Grand Rapids, Mich., a distance of 53 miles.

Chicago, Milwaukee & St. Paul.—This company has brought suit against the Chicago St. Paul, Minneapolis & Omaha to recover lands and benefits valued at $25,000,000, on account of an alleged breach of contract.

Illinois Central.—Sioux Falls, Dak., has accepted the company's proposition and a line will be built to that place from Cherokee, Ia. A survey is in progress for a line from Tuscola *via* Shelbyville to St. Louis, along the line just surveyed by the Chicago, Danville & St. Louis Company.

New Projects & Surveys.—*Winona & Southwestern.*—The survey has begun of this road from Winona, Minn., to Mason City, Ia. The city of Winona has voted $100,000 to the company, and the directors are considering proposals for construction.

Duluth, Watertown & Pacific.—Engineers are cross sectioning this Dakota line between Huron and Watertown, and the grading is to be pushed.

Springfield, Shelbyville & Mt. Carmel.—The survey of this line has been completed from Springfield to Effingham, Ill.

Duluth Terminal.—The Board of Trade of Duluth, Wis., are considering a project for a system of terminal and transfer lines for the use of all roads entering the city.

The Southwest.

Existing Roads.—*St. Louis, Arkansas & Texas.*—Now that the Mt. Pleasant extension is completed to Sherman, Tex., it is said to be the intention of the company to begin at once the survey of a line from Sherman to Abilene. The line from Altheimer to Little Rock, Ark., will be pushed to early completion by MCCARTHY & KERRIGAN, the contractors. The road is to enter the city over the tracks of the Memphis & Little Rock company, with which connection is made two miles east of Argenta. The same contractors will build the Louisville-Shreveport line, and have already sublet 15 miles.

St. Louis, Kansas City & Colorado.—It is stated that the route of this line has been finally determined through Sedalia and Clinton, Mo.

Chicago, Rock Island & Pacific.—Now that the company's trains are running to Wichita and Hutchinson on the southern and southwestern extensions of this company, much interest is excited over the probable route and destination of these lines. As we stated some time ago, the Wichita line is certainly bound for Ft. Worth, and it seems not improbable that it will eventually terminate on the Gulf. The towns and counties along the probable routes in Texas are holding meetings and are ready to offer large subsidies and aid to secure the line. The southwestern line on which trains are now running to Hutchinson, crosses into the Indian Territory in Seward county and runs through No Man's Land into New Mexico. It is stated that the line has been located to Chamita, on the Texas, Santa Fé & Northern, about 35 miles north of Santa Fé. There are various rumors of other likely and unlikely routes through southern Colorado and northern New Mexico, and in the very difficult country through which the surveys are now being made, the detours found advisable may bring places on the line which at present seem remote.

Missouri Pacific.—Engineers are still at work in Perry and Yell counties on the line from Little Rock to Ft. Smith. On the Augusta & White River Line grading is completed to the Bald Knob & Memphis road, and work is in progress on the White river bridge.

New Projects and Surveys.—*Kansas City, Lawrence & Nebraska.*—BREITHAUPT & ALLEN, of Kansas City, have begun the survey of this line.

Kansas, Joplin & Southern.—The survey has been completed from Joplin, Mo., to Van Buren, Ark.

Texarkana Northern.—F. E. HINCKLEY, President of the St. Louis, Kansas City & Colorado, has agreed to build this line from Texarkana to Ft. Smith, Ark., in consideration of $125,000 which has been subscribed by Texarkana.

Dallas, Archer & Pacific.—J. W. CROWLEY, of Salina, Kan., is making a trip over the proposed line of this Texas road, preparatory to submitting a proposal for construction.

Little Rock & Hot Springs.—At the recent meeting of the stockholders of this Arkansas company, steps were taken to insure the early completion of the line.

Denver, Russell Springs & Southwestern.—This company, whose Kansas charter was reported last week, has also filed articles of incorporation in Colorado.

New Orleans, Natchez & Ft. Scott.—The engineers are locating the bridge site near Natchez, Miss.

Rocky Mountain and Pacific.

Existing Roads.—*Colorado Midland.*—This line is now open for business from Colorado Springs to Leadville, 101 miles; and the line is nearly finished between Buena Vista and Leadville.

St. Paul, Minneapolis & Manitoba.—It is said that one of the projects of this company in connection with the Canadian Pacific is for a line from Great Falls to Medicine Hat to connect the two roads. The party in charge of Maj. ROGERS, who have been exploring the Coeur D'Alene country and the feasible routes east of that, were at last reports looking for a pass or possible route through the Cascade range in western Washington territory. The line will probably reach the Sound considerably north of Seattle. On the Great Falls extension the track is laid about 100 miles west of Ft. Buford, and grading is in progress west of Ft. Assinboine. On the Montana Central line from Helena to Butte, all the hands available are pushing the work. The Wickes tunnel is 300 ft. under-ground on the north end.

Burlington & Missouri River.—The company has been negotiating for right of way at Greeley, Col., and has also been examining routes in the vicinity of Ft. Collins.

Union Pacific.—The Utah & Northern line will be changed from narrow to standard gauge on July 25. The work between Spring Hill and Silver Bow, 110 miles, is in charge of FRED J. MILLS. Location is completed of the Oregon Ry. & Nav. Company's extension from Farmington to Spokane Falls.

Missouri Pacific.—Trains will run from Pueblo to Denver over the Rio Grande tracks, as the Atchison, which now runs over the Rio Grande's third rail, will have its own line to Denver by the time the Missouri Pacific reaches Pueblo. Eventually a direct line will be built to Denver by the Gould system, running *via* El Paso, Elbert, and Araphoe counties; but nothing will be done on it at present.

Northern Pacific.—On the Helena, Boulder Valley & Butte line, the track is laid from Jefferson to within six miles of Boulder. The line crosses Boulder divide and in order to reach the summit uses 16 degree curves and three per cent. grades. The road will be completed the present season to Butte, 20 miles beyond the end of track. On the Helena & Northern the grading is two-thirds finished from Birdseye north 12 miles, and an extension has been located to Gloster, 6 miles. The Drummond & Phillipsburg line is nearly ready for tracklaying. Surveys are still in progress on Helena, Boulder & Madison and Helena, Gallatin & National Park roads. Grading is also in progress on the Bitter Root Valley line.

New Projects and Surveys.—*Baker City & Granite.*—This Oregon line is to run from Baker City up Powder river to Sumpter, a distance of 35 miles. The surveys will begin next month. E. H. MIX, Baker City, Oregon is President.

Silverton.—This Colorado company has filed its charter and elected OTTO MEARS of Silverton, President, and J. H. E. WATERS, Chief Engineer.

Yreka Branch.—The town of Yreka, Cal., will vote soon on the issuance of $35,000 bonds for building the branch to the California & Oregon road.

San Francisco & Clear Lake.—This proposed line in Lake county, Cal., is to run from Rutherford to Lower Lake. Surveys have been made and work will be pushed as soon as the county raises the required subsidy. Gen. JOHN T. MCNULTA, Receiver of the Wabash, is interested in the project.